AUSTRALIAN INTERNATIONAL DEVELOPMENT ASSISTANCE BUREAU
MINISTRY OF NATURAL RESOURCES

SOLOMON ISLANDS NATIONAL FOREST RESOURCES INVENTORY

Forests of the Solomon Islands

Volume One:

National Overview & Methods

(Solomon Islands Coat of Arms)

Honiara, February 1995

ACIL Australia Pty Ltd
International Forest Environment Research and Management Pty Ltd
ERSIS Australia Pty Ltd

SOLOMON ISLANDS NATIONAL FOREST RESOURCES INVENTORY

The Forests of the Solomon Islands
Volume One:
National Overview & Methods

Ministry of Forest, Environment & Conservation
PO Box G24 Honiara

February 1995

This is the final version of this report and incorporates all comments received up to 10 February 1995.

STATISTICS

LOCATION:

From:	6° 35'S	156° 23'E	(Astrolabe Pnt, Choiseul)
To:	12° 18'S	168° 48'E	(Tikopia Island, Temotu)

HIGHEST POINT: Mount Popomanaseu, Guadalcanal 2,230 metres

TOTAL LAND AREA: 28,349 sq km

AREA OF CLEARED LAND: (1976 based on Hansell & Wall): 1951.8 sq km

AREA OF DEGRADED FOREST: (1993 based on API by the inventory) 2560.5 sq km

INCREASE: 608.7 sq km (31%) (assumes that cleared land is equivalent to degraded forest)

POPULATION:

Total 1986:	285,796	No. per sq km of total area	10.1
		No. per sq km of cleared land	162.5
Total 1993	359,305	No. per sq km of total area	12.7
		No. per sq km of degraded forest	152.9

INCREASE:

Total	73,509	
No. per sq km of total area		2.6 (+ 25.7%)
No. per sq km of cleared land/degraded forest		- 9.6 (- 5.9%)

AREA OF MERCHANTABLE FOREST: 598,500 ha (loggable area)

INDICATIVE ALLOWABLE CUT: 325,000 cubic metres per year (including an estimated 32,500 cubic metres per year from previously logged areas)

APPROXIMATE ANNUAL RAINFALL: 3,500 mm with 250 rain days (more on higher areas)

CAPITAL: HONIARA

ACKNOWLEDGMENTS

Many many Solomon Islanders helped the inventory to do its work. They included:

- the Ministers and staff of the Ministries of Natural Resources and Agriculture and Land where the project was located, as well as many other Ministers and staff of Solomon Island Government Departments;

- Ministers, Provincial Secretaries and staff of all Provincial Governments;

- chiefs and villagers from 136 villages who gave permission to work on their lands, answered lengthy questionnaires and worked with the field teams;

- non-government organisations who readily helped whenever asked, including SOLTRUST, SIDT and DSE;

- commercial companies who often went out of their way to be helpful: Air Transport Limited, ANZ Bank and Solomon Airlines (to mention only three);

- commercial logging companies who generously made their facilities available to the field teams, particularly the team which measured trees for the volume tables;

- last but by no means least, we acknowledge the contributions made by the field teams and others, whether from Solomon Islands Government or recruited by the project directly: their efforts made the inventory happen.

TABLE OF CONTENTS

SUMMARY viii

1. INTRODUCTION 1

1.1 BACKGROUND TO THE INVENTORY 1

1.2 THE INVENTORY PROJECT 1

1.3 SAMPLING PROCEDURES 2

1.3.1 Timber Inventory 2
1.3.2 Ecological and Environmental Survey 3
1.3.3 Social Surveys 4
1.3.4 Susceptibility of Land to Deterioration 4

1.4 SOME POINTS TO NOTE WHEN READING THIS REPORT 4

2. SOCIAL ASPECTS OF FOREST UTILISATION 5

2.1 METHODOLOGY 5

2.2 POPULATION 6

2.3 LAND 7

2.4 FOREST USE 9

2.5 EFFECTS OF COMMERCIAL LOGGING 11

2.6 ATTITUDES TO FOREST DEVELOPMENT 12

3. LAND RESOURCES AND THEIR SUSCEPTIBILITY TO DETERIORATION 15

3.1 PHYSICAL RESOURCES 15

3.2 REQUIREMENTS FOR PROTECTION 17

3.3 THE LAND SUSCEPTIBILITY CLASSIFICATION 18

4. THE NATURAL ENVIRONMENTS OF THE SOLOMON ISLANDS 22

4.1 INTRODUCTION 22

4.2 BIODIVERSITY AS A BASIS FOR CONSERVATION 22

4.3 ECOLOGICAL BACKGROUND TO THE SOLOMON ISLANDS 23

4.4 METHODOLOGY OF THE ENVIRONMENTAL AND ECOLOGICAL SURVEY (EEFS) 24

4.4.1 Selection of Stratified Catchments 24
4.4.2 Environmental and Ecological Characteristics 24
4.4.3 Outputs from EEFS 25

5.	**THE FORESTS OF SOLOMON ISLANDS**	**28**
5.1	FOREST TYPES	28
5.2	FOREST CONDITION	34
5.3	DISTRIBUTION OF THE MAJOR COMMERCIAL SPECIES	34
5.4	DISTURBANCES TO SOLOMON ISLAND FORESTS	36
5.5	THE ROLE OF CYCLONES	38
6.	**COMMERCIAL FORESTRY ASPECTS**	**41**
6.1	DEFINITIONS AND METHODS	41
6.2	COMPOSITION OF THE COMMERCIAL FORESTS	41
7.	**OTHER FINDINGS OF THE INVENTORY**	**47**
7.1	VOLUME TABLES	47
7.2	PLANTATION OPPORTUNITY AREAS	47
7.3	SUSTAINABLE HARVESTING OF INDIGENOUS FORESTS	48
7.4	THE RECOVERY OF FORESTS AFTER LOGGING	48
7.5	A LOCAL LEVEL PLANNING STUDY	49
7.6	OVERVIEW OF THE SOLOMON ISLANDS FORESTRY SECTOR	49
8.	**MAJOR IMPLICATIONS FOR FOREST-BASED DEVELOPMENT**	**50**
8.1	SOCIAL ASPECTS	50
8.2	ENVIRONMENTAL ASPECTS	50
8.3	COMMERCIAL ASPECTS	51
9.	**REFERENCES**	**53**

LIST OF APPENDICES

APPENDIX 1	LIST OF REPORTS, WORKING PAPERS & MANUALS PREPARED BY THE INVENTORY
APPENDIX 2	LAND COVER AND FOREST TYPE CLASSIFICATION
APPENDIX 3	EFFECTS OF CYCLONES ON THE SOLOMONS FOREST
APPENDIX 4	DETERMINATION OF MERCHANTABLE FOREST VOLUMES AND AREAS, AND REDUCTIONS IN AREAS FOR ENVIRONMENTAL REASONS
APPENDIX 5	ENVIRONMENTAL & ECOLOGICAL FIELD SURVEY PROCESS

LIST OF FIGURES

5.1 AERIAL PHOTOGRAPH OF CHOISEUL SHOWING COMMON FOREST TYPES 30

5.2 FOREST DISTURBANCE 37

5.3 GAP SIZES 38

5.4 AERIAL PHOTOGRAPHS OF PARTS OF GUADALCANAL SHOWING AREAS DAMAGED BY CYCLONE NAMU IN 1986 AND 1992 40

LIST OF TABLES

1.1 INVENTORY UNITS 3

2.1 POPULATION OF THE SOLOMON ISLANDS, 1970 TO 2001 7

2.2 AREAS OF CLEARED LAND AND DEGRADED FOREST, 1974/6 AND 1993 9

2.3 BENEFITS FROM COMMERCIAL LOGGING 11

2.4 PROBLEMS THAT ARE ASSOCIATED WITH COMMERCIAL LOGGING 12

2.5 RESPONSES TO FOREST DEVELOPMENT OPTIONS 12

3.1 LAND SUSCEPTIBILITY CLASSES 19

4.1 GENERAL FOREST TYPES OF THE SOLOMON ISLANDS 26

4.2 AREAS THAT SHOULD BE CONSIDERED FOR CONSERVATION RESERVES IN THE SOLOMONS ISLANDS 27

5.1 MAJOR FOREST TYPES FOUND IN SOLOMON ISLANDS 31

5.2 OCCURRENCE TO THE MAJOR TIMBER SPECIES IN THE SOLOMON ISLANDS 35

6.1 TREES PER HECTARE OF THE MAJOR TIMBER SPECIES (FORESTS THAT HAVE NOT BEEN LOGGED 42

6.2 TREES PER HECTARE OF THE MAJOR TIMBER SPECIES (FORESTS THAT HAVE BEEN LOGGED) 42

6.3 GROSS VOLUMES PER HECTARE OF THE MAJOR TIMBER SPECIES (FORESTS THAT HAVE NOT BEEN LOGGED) 43

6.4 GROSS VOLUMES PER HECTARE OF THE MAJOR TIMBER SPECIES (FORESTS THAT HAVE BEEN LOGGED) 43

6.5 MERCHANTABLE VOLUMES PER HECTARE (FORESTS THAT HAVE NOT BEEN LOGGED) 43

6.6 AREAS OF MERCHANTABLE FOREST IN EACH PROVINCE 44

6.7 VOLUMES OF MERCHANTABLE TIMBER (UNLOGGED FORESTS) 45

6.8 PRECISION OF VOLUME ESTIMATES 45

6.9 PERCENTAGES OF LOGS WHICH IN FORM CLASSES I AND II 46

LIST OF MAPS

1.1 REGIONAL INVENTORY UNITS vii

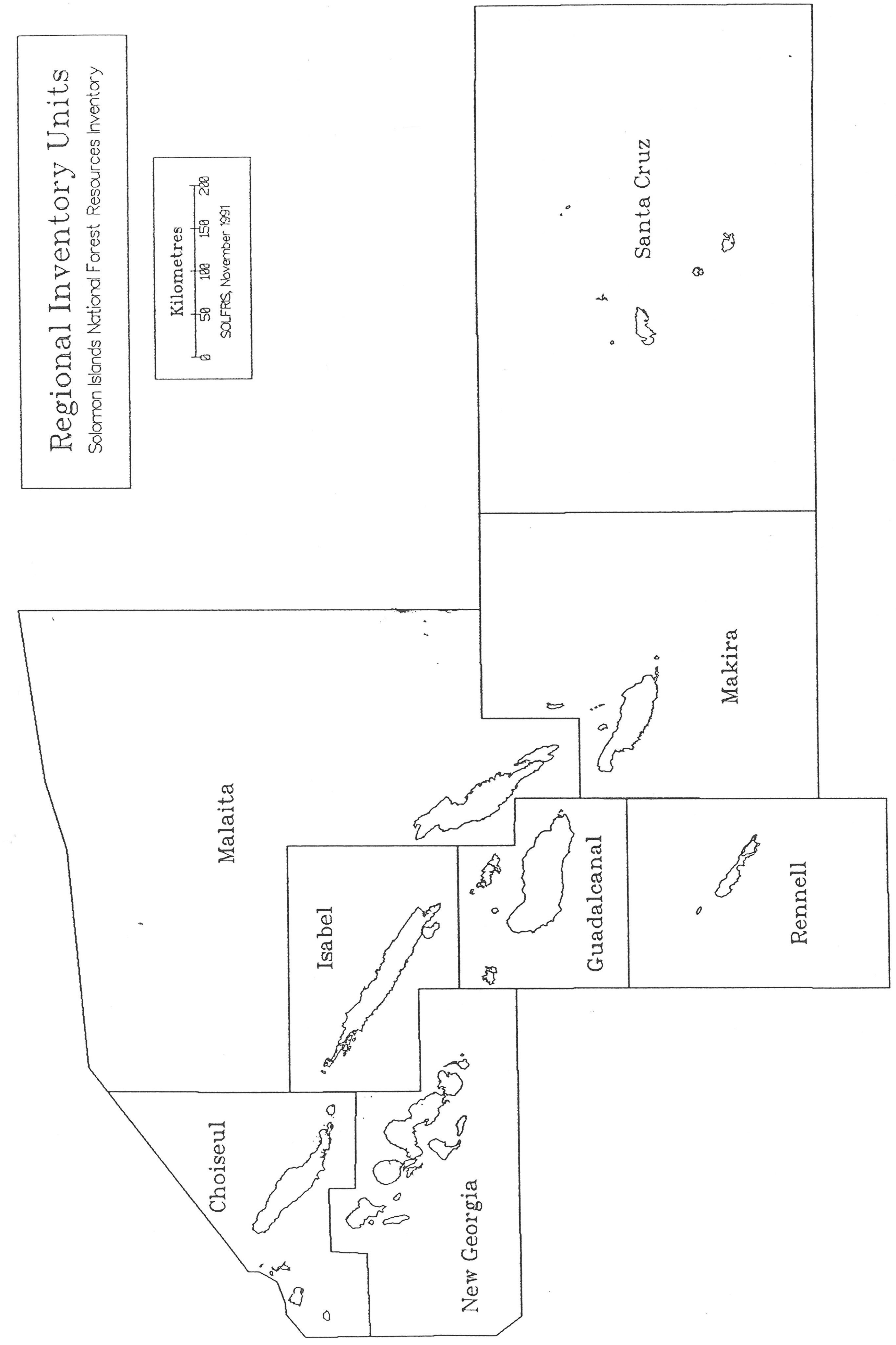
3.1 GEOLOGICAL PROVINCES 16

3.2 LANDS THAT ARE MOST SUSCEPTIBLE TO DETERIORATION 21

5.1 RUSSELL ISLANDS FOREST TYPE AND SLOPE 32

5.2 BAGA FOREST TYPES 33

Map 1.1



Regional Inventory Units
Solomon Islands National Forest Resources Inventory
Kilometres
0 50 100 150 200
SOLFRIS, November 1991
Santa Cruz
Makira
Malaita
Isabel
Guadalcanal
Rennell
Choiseul
New Georgia

SUMMARY

SUMMARY

The need for a national forest inventory of the Solomon Islands has been recognised for many years. Such an inventory is seen as necessary for the calculation of sustainable yields and to formulate realistic strategies for the forest sector.

Following an official request from the Solomon Islands Government in April 1986, the Government of Australia agreed to assist in carrying out the inventory for which a pilot study commenced in late 1990. By this time the need and opportunity to collect more than just the data to calculate sustained timber yields had been recognised. Therefore, in addition to collecting data on gross volume by diameter and species classes, merchantable volume, topographic details for area planning, soil types and accessibility, the project collected data on the non-timber values of the forests. These values included: community uses of forests (materials for construction, food, medicines, custom plants, cultural values etc), the susceptibility of soils to degradation, botanical topics, and ecologically significant and environmentally sensitive areas.

With the advent of powerful desk top or "personal" computers, the concepts of handling the large amounts of data collected during a forest inventory have changed. Furthermore, it is now possible to quickly draw maps with these computers using geographic information systems. Therefore, it was decided that the data collected by the inventory would be held in computerised data bases to be available as print outs in map or written form. The overall goal of the inventory project was to establish a computerised data base that would improve the capacity of the Solomon Islands Government to determine reliable short and long term strategies for forest development planning for commercial and non-commercial uses including conservation.

To achieve this goal, the project had six components: establishing the computerised data base to a point where it is used by Solomon Islanders for forestry planning; estimation of timber values; a non-wood values component which was concerned with protective and environmental values, and with community uses of forests; a preliminary resources planning component; a training component, which concentrated on "hands-on" training so that SIG officers were well trained in the many techniques used in the inventory; and a project management and reporting component.

The inventory was required to be conducted on a regional basis, and eight regions were identified to cover the whole of the Solomon Islands. Separate reports specify the results of the inventory for each region. This volume is a summary volume which presents a national overview and gives details of the methods used by the inventory.

Most of the lands within these regions were sampled. Some islands were not included. Usually these were considered not to carry forests that are attractive for commercial logging (eg., Ulawa and Bellona). A few islands which have forests of commercial quality were not sampled. For example, it was considered prudent not to visit the Shortland Islands which are close to Bougainville, at the height of the crisis, and Rob Roy and Vaghena Islands were considered to have greater ecological than commercial significance.

Several **special studies** were undertaken during the inventory. A list of the reports, working papers and manuals prepared during the inventory is included in Appendix One. One of the most significant of these was a preliminary study to establish permanent sample plots. This study found considerable evidence that the forests will not recover from the present logging methods to produce another crop of timber in the foreseeable future. Another document, Project Working Paper 14 gives a methodology for future sustainable harvesting of the indigenous forests.

Other studies included: plantation opportunity areas (found to be more significant in the Western Province than elsewhere), a set of volume tables, local level planning and an overview of the Solomon Islands forestry sector.

The **study of social aspects and issues** clearly showed that land owners and other resource users depend on the forests for a significant portion of their subsistence needs. If there is further substantial depletion of forest resources while the rapid increase in rural populations continues, living standards, health, and nutrition of rural people will decline in future. Therefore there is a need for forest resources to be protected to meet the needs of present and future rural populations.

The inventory estimated that between 1,200 and 1,800 hectares of primary forest was converted to "gardens" each year and that by 1996 this could be between 1,800 and 2,500 ha annually. With rapidly growing population and competing uses for lands and forests, shifting agriculture as now practiced cannot be sustained. Improved farming systems, which should include tree crops and agro-forestry, need to be introduced.

The value of wildlife trade (as reported to the central government) is about $ SI 2 million per year. This trade is probably not sustainable but there are good opportunities to develop this through butterfly farming, crocodile farming and eco-tourism, etc.

There was found to be a widespread understanding of the adverse effects of deforestation among village peoples, and also widespread disappointment with logging operations. This was not so much because logging companies had not kept their promises but because streams had been damaged, soil erosion was sometimes widespread and there had been damage to gardens and tambu sites. The advent of land disputes was common and logging was often seen to be socially disruptive. Surveys of villagers attitudes to forest development options indicated that developments involving outsiders are generally not acceptable. All regions were more or less equally well disposed to small scale logging by locals.

The **land resources** of the Solomon Islands were found to be mostly in good condition, and the inventory concentrated on identifying lands which would be subject to damage if the forests were disturbed. Five classes of land were identified according to the stability (or otherwise) of soils, intensity of rainfall and occurrence of seismic (earthquake) activity. Maps were made of these classes, (shown in each regional report) and it is recommended that there be no disturbance on the most susceptible lands. Because they are entered into the FRIS and NATRIM the maps can be used for a variety of purposes. Such use would need to consider the appropriateness of the method used in this study in identifying the susceptibility classes.

The **ecological and environmental** aspects of the Solomon Islands forests require many different values to be considered in order to identify and describe the non-timber resources. These include water quality, the occurrence of rare and endangered species of flora and fauna, genetic diversity (and its need to be conserved) and ecological processes. The data gathered for each province was used;- to identify and describe environmental domains (areas where there are similar physical, environmental characteristics, eg., climate, topography, land form, geology, soil); describe the botanical structure and floristics of the forests; identify major centres of biodiversity and of biological significance; identify areas that governments should consider for some form of protection; and identify places in which there should be constraints on logging to protect local resources or downstream values such as swamps, reefs and fishing grounds. Each regional report includes a comprehensive report on ecological and environmental implications of forest resource utilisation plus maps delineating areas of outstanding conservation value, areas where susceptibility to degradation should prevent logging and areas where commercial operation can be considered if suitable operational controls are in place.

To **describe the forests of the Solomon Islands,** six basic forest types were identified from aerial photographs: saline swamps (mainly mangroves); freshwater swamps and riveraine areas; lowland forests; hills rainforests; upland (or montane) forests and non-forest areas. These were classified according to species composition, canopy density and crown size. Maps of the different forest types were prepared from aerial photographs.

The studies into the botanical aspects of the forests showed that the major disturbances are by wind or cyclones, and animal digging. Gaps and gap size were found to be important, with 56% of plots having large gaps, 29% having many gaps and only 13% having small gaps.

The resulting picture of Solomon Islands forests is one of disturbed forests with many gaps, high levels of light penetrating the upper and middle canopies (but not necessarily reaching to the ground) with abundant and vigorous seedlings and small saplings (99% of plots had seedlings present). This has implications for forest management. If the forests are accustomed to disturbance and are able to recover from disturbance (eg. from the many seedlings that are present) then they should be able to recover from logging if it is done in a way that imitates the natural disturbances.

Commercially, the forests of the Solomon Islands Provinces may be grouped into high volume forests (Choiseul and Western Province, and, presumably the Shortland Islands, which have not been exposed to cyclones as much as the rest of the Solomons), medium volume forests (Isabel, Malaita, Guadalcanal and Makira), and low volume forests (Rennell and most of the Temotu forests).

It has been anticipated that the inventory will be followed by a national forestry plan as stated in the statement of forest policy issued by the Solomon Islands Government in 1989. Therefore the role of the inventory was seen as one of data collection, rather than one of interpreting the data. Nevertheless, an indicative annual yield was calculated for each province to assist with provincial and national planning.

The inventory made an estimate of the gross volume of timber for each major province with a reliability of plus or minus 10% with a 95% chance that this figure will be obtained again if the same inventory were repeated (the same figure would be obtained, within the ± 10% limits, 19 times out of twenty). A lower figure was acceptable for less important regions. From this gross volume, a merchantable volume was obtained, as described in Appendix Four of this volume, and the total areas of forest types were reduced to give "loggable" forests. Then by subtracting areas that should not be logged, such as stream side strips, areas around villages, areas that protect swamps and mangroves and areas of high biodiversity which should be conserved, a "reduced area" was obtained. This was then used to estimate an indicative allowable cut assuming a 45 year cutting cycle. (Note that the procedure was slightly different for some of the regions, but that this does not affect the final outcome.) The total annual cut was estimated in this way to be 325,000 cu m per year comprised of 304,500 cu m from unlogged and an estimated 20,500 cu m from previously logged areas. This figure is one that should be regarded as indicative rather than prescriptive. However, if the volume being logged annually is much more than this, there are likely to be grave social and environmental consequences.

INTRODUCTION

1. INTRODUCTION

1.1 BACKGROUND TO THE INVENTORY

The need for a national inventory of the Solomon Islands forests has been recognised for some time: without a good overall knowledge of the forest resource, it is not possible to plan and manage forests for sustainable yields nor to formulate realistic strategies for the forestry sector.

Following a request by the Solomon Islands Government (SIG) in April 1986, the Government of Australia (GOA) agreed to assist in carrying out a national forest inventory. A Memorandum of Understanding was signed on 20 October 1990 to implement the Solomon Islands National Forest Resources Inventory Project and a contract was let by the GOA to a consortium of three Australian companies to be responsible for the Australian inputs.

A pilot study was then carried out in Eastern Guadalcanal, from November 1990 to February 1991. The experiences gained during the pilot study were used to design the main phase which started in August 1991 and continued until December 1993.

Originally the SIG expected that the inventory would provide the following information: estimates of gross volume by diameter and species classes on a per hectare basis; total merchantable volume by diameter and species classes; topographic details sufficient for good area planning; soil types with an indication of bearing capacity; broad estimates of accessibility. Initially therefore, the project was designed to assess the amount of timber available from the Solomon Island forests, as a basis for a program where extraction could be based on long term sustainability.

However, there is now an increasing awareness in the Solomon Islands and elsewhere that the non-timber values of natural forests are extremely important, particularly for the traditional lifestyles of the islanders themselves. In Australia, too, public opinion is such that full consideration has to be given to the non-timber values of forests, and that forests must be managed for these values as well as for commercial purposes.

Consequently, the project was designed to include several non-timber components, and it changed from being a simple "timber inventory", to a "forest resources inventory" which took into account community uses of forest materials for construction, food, medicines, custom plants, cultural values etc, the susceptibility of soils to degradation, identification of ecologically significant areas and environmentally sensitive areas, as well as more conventional values such as timber volumes.

The inventory was also required to be conducted on a region by region basis, and eight regions were identified to cover the whole of the Solomon Islands (see Map 1.1).

Several other studies were undertaken during the inventory: a complete list of reports, working papers and manuals prepared during the inventory is included in Appendix One.

In many tables areas have been rounded to the nearest hundred where this is considered to be sufficiently accurate.

1.2 THE INVENTORY PROJECT

With the advent of powerful desk top or "personal" computers, the concepts of handling the large amounts of data collected during a forest inventory have changed. Also it is now possible to quickly draw maps with these computers using Geographic Information Systems (GIS). Therefore, it was decided that the data collected by the inventory would be held in computerised data bases to be available as print outs in map or written form, and the overall goal of the Project [as stated in the Project Implementation Document (PID)] would be:

> ***"through a Forest Resources Information System (FRIS) to improve the capacity of the SIG to determine reliable short and long term strategies for forest development planning for commercial and non-commercial uses including conservation".***

To achieve this goal, the project was designed to have six components:

- **establishing the computerised data base (FRIS)** to a point where it is used by Solomon Islanders for forestry planning;
- the **timber values** component which estimates the nature and extent of the potentially commercial forests, relying greatly on aerial photographs;
- the **non-wood values** component, concerned with protective and environmental values, community attitudes and uses of forests;
- a **resources planning** component consisting of several sub- components: establishment of a FRIS users' group, a case study of an area with potential to establish plantations, establishment of planning guidelines, establishment of plots to measure the recovery of forests after logging, and dissemination of the implications of the inventory to the villagers who helped with the field work;
- a comprehensive **training** component, which concentrated on "hands-on" training so that SIG officers were well trained in the many techniques used in the inventory ; and
- a **project management and reporting** component.

1.3 SAMPLING PROCEDURES

Clearly a sampling procedure was necessary. The number of samples required has been calculated statistically to meet the requirement of an estimate of gross volume for each important region that is within $\pm$ 10%, with 95% probability of being correct. That is, if the inventory were repeated the answer would be within 10% in 19 cases out of 20.

For the less important regions a lower precision would be acceptable. Information on precision of estimates of volume is given in Chapter Six.

For most of the regions of Solomon Island, it was most efficient to conduct a two-stage sampling process, but in Temotu and Rennell a simpler process was used.

The country was divided into Regional Units based on island groups with similar forest types. These Regional Units usually conformed to Provincial boundaries, the exceptions being Central Province (which was included with Guadalcanal), Ulawa, and the Shortland Islands which were to be included with Choiseul, but in which no field work was actually carried out.

In most cases, the Regional Units were divided into Sub Regional Units (SRUs). These contained sizeable areas of commercial forest, generally below 400 metres, on a ruling slope of less than 30 degrees and estimated to carry not less than 20 cubic metres per hectare of timber that can be utilised (harvested) now or in the near future, using logging practices current in Solomon Islands.

This general approach meant that the ecological and social work carried out by the inventory was biased towards forests that are suitable for large-scale commercial logging and nearby areas, and that the villagers who were interviewed were those who lived near areas of forest that were to be sampled for the inventory. Logistically this made the project much easier to manage, and it also concentrated the work on forests that are likely to be logged.

1.3.1 Timber Inventory

In the first stage of the two-stage sampling process, samples were selected randomly from the SRUs which may have forests of commercial quality. They were delineated by major topographic features (usually rivers).

The selection of SRUs was on a basis of probability proportional to size (of forest area) so that the larger SRUs had a better chance of selection than the smaller ones. The selection process also gave a greater chance to SRUs that had not yet been logged. However, SRUs that were adjacent to an SRU that had already been selected were rejected. In each region, about 20% (but a minimum of five) of the SRUs were selected in each region, for the second stage which involved setting up plots along pre-selected transects or "strip-lines".

The procedure followed to identify the SRUs was to use the FRIS to generate a map showing coastlines, major rivers, 400 metre contour lines, watersheds, 30 degree slopes, forest areas and logged areas.

In practice, it was not easy to select the SRUs since there were no up-to-date maps showing the conditions of forests for the regions. Air photographs had to be used to identify the areas with a forest cover that could contain timber in commercial quantities.

A list of the units used in the inventory is given in Table 1.1, and a more detailed description of timber inventory methods is given in Field Manual Number 1 (Hammermaster, 1992).

TABLE 1.1
INVENTORY UNITS

UNIT	DESCRIPTION
REGIONAL UNIT (RU)	based on island groups
SUB-REGIONAL UNIT (SRU)	selected from areas which contain possibly commercially loggable forests (forested, below 400 m and less than 30 degrees slope)
TRANSECTS	starting point randomly selected along a chosen base line
TIMBER INVENTORY PLOTS	located each 100 m along transects with the distance of the first plot randomly chosen between 50 and 150 m
TREES	measured in 20 m radius plots at 100 m intervals for trees over 60 cm diameter and in 5m and 10 m radius sub plots for trees below 59 cm diameter (20% of plots)
ECOLOGICAL & ENVIRONMENT SURVEY PLOTS	located in 20% of timber inventory plots and/or nearby

Having selected the SRUs, the second stage of the sampling process was to randomly select the starting points of transects (or "strip-lines") from baselines that had previously been located along the best access within the SRU (along ridges, rivers, coastlines, etc). Usually there were four transects per SRU. In addition, the location of the first sample plot on a transect was also selected randomly, thereafter 20 metre radius plots were located at 100 metre intervals along the transect. All commercial tree species over 60 cm diameter in the plots were measured, and on 20% of the plots (also randomly selected) all trees between 30 and 59 cm were measured in a sub-plot of 10 metre radius to give an indication of trees that will be harvestable in the future. Except in the regions measured in the early stages (Guadalcanal and Malaita) a smaller (five metre radius) plot was also established to give an idea of the number of smaller trees (10 to 29 cm diameter) that were present.

1.3.2 Ecological and Environmental Survey

While the field teams were working in an SRU, data was also collected on ecological aspects of the forests.

Generally, it was hoped to sample as many as possible of the land systems (areas of similar land resources) that were identified by the land resources survey carried out in the 1970s (Hansell and Wall, 1974-6) and plots for the ecological and environmental survey (EEFS) were located in the transects that were being sampled for the timber inventory (generally using the 20% of plots that contained sub-plots) and in nearby areas where additional land systems or environmental domains could be sampled.

In each plot, data was collected on botanical structure, floristic composition and customary uses (with names in local languages). In the later stages of the inventory, colour pictures were used to obtain data on the occurrence of birds in forest areas, by asking villagers to identify which of them were seen in their areas.

It was not possible with the time and resources available to sample all land systems occurring in the country, although every effort was made to cover as wide a range as possible, especially in the lowland areas.

1.3.3 Social Surveys

Lengthy interviews were conducted in villages in or near the SRUs usually in the evenings, by the same teams that were responsible for collecting EEFS data. They used a special form to record responses. The interviews were also recorded on tape, to give an important historical record of communities' attitudes and responses to forest utilisation issues, in addition to providing valuable additional information on biological resources and species of interest. About 20 villages were to be interviewed in each region.

In the earlier stages, it was found that although a few women attended village meetings, they rarely spoke out. Therefore it was decided to hold separate meetings with women. "Women's interviews" were held with five women from each village, concentrating on recollections of food that had been eaten in their households during the past 24 hours.

1.3.4 Susceptibility of Land to Deterioration

In the early stages of the project, it was proposed to estimate "catchment condition" (the extent to which each land in each catchment had deteriorated). However, it was soon found that most catchments in the Solomon Islands are still in good condition, and that it would be better to investigate the susceptibility of lands to deterioration. This was done by using the data collected by the Hansell and Wall study, particularly the descriptions of land facets and land systems, and deriving criteria from rainfall and seismic (earthquake) records (Aldrick, 1993). Unlike the other activities discussed here which required much field work, this item was largely a "desk study" using existing data.

1.4 SOME POINTS TO NOTE WHEN READING THIS REPORT

The information collected by the inventory is suitable for planning at national and provincial levels but can only be indicative at local or village levels for which more precise information should be collected.

The botanical names in this and other volumes are those in use in the Solomon Islands at the time of the inventory, even though some have been changed recently for taxonomic reasons (eg., *Casuarina papuana* is now known as *Gymnostoma papuana*).

Slight discrepancies will be found when examining and comparing the various tables in these reports. This is because it is not possible to be precise to the nearest hectare when working at the large scales necessary for a national forest resources inventory.

FRIS and NATRIM are acronyms used for the geographic information systems developed by the inventory (Forest Resources Information System and National Resource Information and Mapping).

SOCIAL ASPECTS OF FOREST UTILISATION

2. SOCIAL ASPECTS OF FOREST UTILISATION

This chapter is drawn from project Working Paper 19 which contains a full discussion and presentation of the results of the sociological work of the inventory, based on a survey of 139 villages in or near forest areas.

2.1 METHODOLOGY

A pilot study was conducted in late 1991 in villages in Longgu District in Eastern Guadalcanal. Five separate communities with a number of discrete hamlets were studied in two visits to gain a detailed picture of the villagers' relationship with the forest and other resources. At the same time the viability of three potential methods for collecting sociological data were tested for use in the wider Inventory study. As some of the communities were experiencing logging at the time and others had been approached by the logging company but were still considering the matter, a preliminary assessment of the social and economic impacts of logging was also undertaken. The pilot study used participant observation, individual and household interviews, village meetings and participatory resource mapping to gather information and to examine local forest issues, including resource trends and development options. Two questionnaires were developed for testing in association with the pilot - a village questionnaire, administered as part of village meetings and a household questionnaire administered to a random sample of households in each hamlet. The utility and appropriateness of the question items in each questionnaire were also tested. The participatory mapping exercise was also tested in each of the village meetings.

The pilot study determined that the village meeting-based survey was suitable and viable given the time and resources that would be available for the sociological inventory, and that the participatory mapping could be carried out to reasonable effect.

Selection and training of the EEFS field teams, which were to have the task of carrying out the sociological and environmental inventory fieldwork was carried out in mid 1991. Potential team members were recruited for initial training by written application and then interviewed. Care was taken to include women and people with a variety of languages. Short listed candidates were then put through a two week training program combining both environmental and sociological aspects. Following this training, the candidates were evaluated and the team members selected. The field teams, including their team leaders drawn from the Ministry of Forests, Environment and Conservation staff, were then given further training in interview techniques, record keeping, fieldwork logistics and other necessary skills, and several trial village surveys were carried out in villages near Honiara. In addition, a detailed sociological field work manual was prepared.

Data from the 1986 Census of Population was entered on the FRIS (enumeration and ward boundaries, village locations, populations, numbers of households, numbers in paid employment, dependency ratios and population changes since 1976). Other "social" data, information about the human communities who own the forests and their interaction with the forests collected by the field survey teams, has been entered on the data base linked to the FRIS. From the outset the survey team acknowledged that the forest resources of the nation are largely in customary ownership. It was therefore designed to enable considerable input from local communities. Indeed, apart from the village level data from the 1986 Census of Population and some field observations of garden sizes, all of the data in the sociological inventory was gathered directly from the village based resource owners.

Before inventory field work commenced in each regional unit, permission to interview village people was obtained by Forestry Division staff from chiefs and landowners and the Provincial Government concerned. The field teams selected accessible villages within or close to the boundaries of each area sampled (up to three villages per area) so that the data about forest utilisation by landowners could be linked to the data on timber resources and the environment. The survey teams used two main instruments:

(i) Village Interview Schedule

Village interviews were based on an interview schedule. The interview was arranged by the team leader and the village head-man, and all members of the community could attend (usually a representative number did so). Interviews were lengthy, usually four hours or more long. A set of standard questions was asked by the team leader, discussed and answered by those present, and recorded on a form by another team member. The interviews were also tape recorded as a control. A map was used to discuss land tenure and land and resource use. Informants were asked to indicate clan land boundaries, approximate location of sacred sites, hunting and fishing areas etc. Other topics covered in the interview were: local social structure and organisation; the local economy and horticultural systems; use and availability of resources in or associated with the forest (plants, animals, water, land); and knowledge, attitudes and practice regarding commercial uses of forest resources (such as commercial logging, large scale plantation forestry, small-scale agroforestry, and small-scale logging and timber cutting).

Interviews were arranged at times that fitted in with leaders and according to the logistics of the teams' work schedules (which were often tight as they had to keep pace with the forestry teams doing the timber inventory so that they could use the same transport facilities). Usually, the best time for interviews was in the evening when most people were present in the village, but this was often not logistically possible. Therefore, men tended to be predominant at village interviews as the women being away in their gardens during the day or otherwise engaged. The typical number of people attending meetings was between one and 40 people, with under 20 attending in a greater number of villages. In very few instances were there less than eight people at the interview.

ii) Food Resources Data Form

The second instrument was a food resources data form used by the women on the field teams to collect data from a group of five mature married village women on wild food (plants, trees, animals, birds, reptiles, freshwater and marine plants, fish and other edible species), and on cultivated food plants. In addition, each woman in the group was asked to provide a separate dietary recall for herself and her family for the preceding 24 hours.

2.2 POPULATION

Most Solomon Islanders live in villages located in or near forests. Those who live inland depend heavily on forest resources and those who live in coastal areas make extensive use of marine resources, which however, require forest materials, eg special trees for canoes. The forests are used to supply the materials for traditional dwellings, for hunting, gathering wild food, medicines, canoe wood, tools, materials for crafts and other traditional purposes.

The population of the Solomon Islands is increasing at 3.6 per cent per year (doubling in about 20 years). Past, current and projected distributions of this population to 2001 are shown in Table 2.1.

It has been clearly shown by the inventory that land owners and other resource users depend on their forests for a significant proportion of their subsistence needs. Few villagers have access to cash in other than small, sporadic amounts and therefore their ability to undertake local development is limited. The depletion of their forest resources, coupled with rapid population growth, means that living standards, nutrition and health of rural peoples will decline. Conservation of adequate areas of forest is therefore essential to their well being. Accurate assessments of the amount of forest required by present and projected local populations are needed and such areas need to be protected.

Both timber and non-timber resources are showing signs of pressure from both expanding populations and commercial logging. Both men and women are being affected by the slow depletion of forest materials, wild foods and garden lands. In a country where the monetary economy is already under great pressure, Solomon Islanders are likely to become increasingly dependent on natural resources to meet their daily needs for a *balanced* diet and various materials.

At the same time the national economy is under increasing pressure to provide social services, which are currently being paid for by the commercial exploitation of these resources. As a result Solomon Islanders must face a slowly deteriorating quality of life accompanied by the further loss

of natural resources: the threat of a downward spiral into pernicious poverty over the coming decades is very real.

TABLE 2.1
POPULATION OF THE SOLOMON ISLANDS, 1970 TO 2001

Province *	1970	1986	1993	2001	area sq km	Density 1986	Density 2001
Western	32,231	55,372	85,220	112,377	9313	5.9	12.1
Isabel	8,653	14,564	16,960	26,439	4136	3.5	6.4
Central	10,922	18,522	21,725	34,925	1286	14.4	27.2
Guadalcanal	23,996	50,327	61,200	70,791	5314	9.5	13.3
Malaita	51,722	80,183	91,200	119,518	4225	19.0	28.3
Makira	12,390	21,646	27,000	33,703	3188	6.8	10.6
Temotu	9,078	14,683	17,500	24,145	865	17.0	27.9
Honiara urban	11,191	30,499	38,500	54,411	22	1750	2473
Total	**160,183**	**285,796**	**359,305**	**476,309**	**28,349**	**76.1**	**125.8**

* Since 1986, Choiseul has been separated from Western Province, and Rennell/Bellona from Central Province

Source: National Statistics

Life expectancy is 59.9 years for males and 61.4 years for females. Women of child bearing have on average 6.4 children in the course of their child bearing years.

2.3 LAND

The inventory collected data on land boundaries and resources using participatory mapping. From the 102 maps that were compiled, the average area claimed by each village in the survey as being their own land was about 47 square kilometres. However, this varied considerably between regions (Choiseul, 18.2 sq km; Guadalcanal, 12.8; Isabel, 64.0; Makira, 40.0; Malaita, 66.2; Rennell , 47.7; Temotu, 87.4; Western, 34.0).

For all villages in the survey, the average distance to the furthest boundary of the village territory was 8.5 km.

Tambu sites

Tambu sites, and the ritual observances associated with them, have increasingly lost their significance in the lives of ordinary Solomon Islanders as western values have become more embedded in local cultures. However, knowledge of the history and ownership of sites is particularly important when it comes to resolving disputes over land ownership. In addition, there is interest in preserving sacred sites and other traditional values, while in some areas visits to sacred sites are offered to tourists. Some provincial governments have been attempting to record tambu and historic sites for their cultural value, as well as for their use in establishing customary land ownership however, only 11 villages (8%) reported that the government or the national museum had registered or surveyed tambu sites.

Gardens

Ninety percent of the population is reliant on subsistence gardening, especially the production of staple root crops. This gardening is carried out on a shifting basis, generally using "slash and burn".

Sites for gardens are generally selected on the basis of apparent fertility (judged from the vegetative cover) accessibility and convenience, slope, drainage and ownership. Accessibility seems to be a crucial factor: on average, household food gardens are about 23 minutes walk from the home.

Three hundred and four garden plots were measured and their size was found to be just under 3,000 sq m (0.3 ha). There is some difficulty in relating size to these plots since it is common for families to jointly clear an area of forest, and then share the cleared area.

Taking this number of plots per household and a plot size of 0.3 ha, the average garden area under cultivation at the time of the survey would have been approximately 0.9 ha. (This is approximately four times the average household food garden area recorded in the Solomon Island Farmer Studies (SSFS) which note that small holders who also cultivate tree crops had average holdings of 1.78 ha, of which 0.26 ha is in food gardens, whereas those who do not have tree crops (52%) had average holdings of 0.23 ha).

Using the number of rural households recorded in the 1986 Census (37,500) then the amount of land actually under cultivation by households would be about 36,500 ha, with 9,400 ha in food gardens and 27,100 ha under tree crops.

Clearing of "Primary" Forest for Gardens

On average, about 32% of the gardens under cultivation had been cut from "primary" forest. This proportion varied considerably between regions, and approximately three quarters of surveyed villages reported that they cut 25% or less of their gardens from primary forest. This may, however be an over estimate since the SSFS recorded an average of 19% of the food garden area is cut from primary forest. (Here primary forest is forest which has not been disturbed by gardening for 30 years.)

Length of Cultivation of Gardens and Fallow Periods

The inventory found that the average period of cultivation was approximately 16 months. The longest period was 20 months in Guadalcanal and Western Provinces, and the shortest 9 months in Rennell. Earlier work indicated that the average length of cultivation before fallow was 17 months (SSFS) giving 2-3 root crops in succession - often consisting of pana or yam at the start followed by sweet potato or perhaps cassava. It is noteworthy that the 1974-75 Agricultural Statistics Survey found that only 7% of gardens were cultivated for 12 months or more before being left fallow, and that the national mean cultivation period for a garden was 6 months.

The inventory found a considerable range in the fallow period, with the mean being 3.8 years, but ranging from only a few months to 10 or more years. The mean fallow period was slightly longer for villages located in hill areas (4.2 years) compared with coastal villages (3.8 years) and those located on coastal plains (3.3 years). Villages in the Malaita region had the longest mean fallow period (5.8 years), followed by Choiseul (5.0), Temotu (4.6), Guadalcanal and Rennell (4.2), Isabel (3.6), Makira (2.8), and Western (2.1 years).

From this and earlier work, eg. the 1974 Agricultural Survey, it seems reasonable to accept a figure for fallow of 4-6 years when planning at the national level (however, there is such a wide variation that it would be advisable to disaggregate to provincial levels).

Villagers were asked if land was left fallow for longer in their father's day than today, and if so, why had this changed. Overall 81% of villagers said that the land was left fallow for longer in their father's day, 17% said it wasn't, and 2% did not know. This overall pattern holds for coastal, plains and hills villages, and in all regions, except for Malaita. In the case of Malaita, which recorded the longest average fallow period (5.8 years) more than half the villages said that the length of fallow was **not** shorter than in their father's day. Of the villages which reported that fallow periods were shorter today, 95% said that population growth was a key factor. This together with changes in crops, cropping methods, land use and life style have combined to produce a situation of intensifying land use which can be expected to lead to declining productivity unless compensating measures are taken.

Amount of Forest used for Gardens

It was not possible to directly compare areas of cleared land as recorded earlier by Hansell and Wall, 1974-76 with the inventories findings because air photograph interpretation by the inventory recorded degraded forest rather than cleared land. However, Table 2.2 indicates a definite trend to more forest being lost, the extent of which should be verified by a more detailed examination. Monitoring at regular intervals of five to ten years, of clearing for gardens and cash cropping, using satellite imagery and/or aerial photography, is urgently required in the Solomon Islands. If it is assumed that degraded forest estimated by the inventory is equivalent to Hansell and Walls area of cleared land, then the loss of forest has been 2.1% in about 20 years, or an increase in the area of cleared land of 31.2% for the whole country.

TABLE 2.2
AREAS OF CLEARED LAND AND DEGRADED FOREST, 1974/6 AND 1993

Province	Cleared Land 1974/6		Degraded Forest 1993		Forest Area Lost
	sq km	%	sq km	%	%
Guadalcanal	776.1	14.5	887.5	16.6	2.1
Malaita [1]	65.7	2.9	148	6.5	3.6
Choiseul	95	2.9	179	5.4	2.5
Isabel	220	5.3	382	9.1	3.8
Western Province[2]	340	6.8	420	8.4	1.6
Makira	178	5.4	222	6.9	1.5
Central	190	30.1	210	33.0	2.9
Temotu	64	8.0	87	10.7	2.7
Rennell[3]	23	3	25	3.8	0.8
Total	**1951.8**	**6.9**	**2560.5**	**9.0**	**2.1%**

[1] does not include Ulawa [2] does not include Shortlands [3] does not include Bellona.

The inventory estimated that, based on the 1986 population figures, 1,500 ± 300 ha of primary forest is currently being cleared for food gardens per year, and that by 1996 this could be 2,150 ± 350 ha per year.

If all food gardens were allowed to stand fallow for 30 years (generally considered long enough for the forest to recover and for soil fertility to return naturally) and with no increase in the size of household food gardens, the average area per household to sustain food production over the 30 year period would be in the order of 5.5 ha.

With a rapidly growing population, and competing uses for lands and forests, shifting agriculture as it is now practiced cannot be sustained - soil and forest resource depletion are known to be increasing, and land use and social conflicts must inevitably result, with its attendant human hardship. It is vital that more sustainable subsistence gardening systems should be introduced.

2.4 FOREST USE

The frequency of collecting forest materials ranges from those collected "very frequently", such as firewood, to building materials which are only collected "as needed" (when a new house is needed or repairs are made).

Wild Foods

Given that protein is relatively scarce, small animals, lizards and birds which are taken from the forest provide an important supplement to the more common fish and other sea and freshwater creatures that are generally consumed.

Food species mentioned to the inventory teams included megapodes, cockatoo, hornbills, seagulls, pigeons, doves, ducks and parrots. Birds' eggs were also collected. Wild pigs were hunted by many of the village groups and kandora, wild cats, dogs, goats, rats, possums, flying foxes, and land crabs were hunted almost as often. Reptiles such as unu, iguana or snakes, and frogs, worms and grubs were also collected.

If garden foods were unavailable, for instance after a cyclone, wild foods would make up an important part of the diet. However, few people thought they would be the only food supply, with most villagers expecting to be still able to find some fruit, such as bananas, which grow in or near gardens, and root crops. Store foods such as rice were also mentioned by the majority.

Firewood

All of the villages in the village survey gathered firewood from the forest. This is mainly used for cooking and is usually readily available, being gathered from recently cleared garden areas (within 30 minutes' walk of villages in 74% of cases, with little variation between provinces).

Villagers in Guadalcanal were most likely to report firewood as harder to find (in 29% of villages). The percentage for other provinces ranged between 7% and 20%. In cases where fuelwood availability is declining, villagers have to travel further from home to collect the necessary supplies as no substitutes are available and there are some parts of Honiara where the lack of easy access to firewood causes hardship.

Medicines

The inventory showed that villagers use medicine collected from the forest and that most medicines can be gathered within a few minutes walk of the village. Less than 20% of cases reported that they took longer than 30 minutes to find.

There is a need for customary uses of plants to be recorded, and the inventory made a start by recording the customary uses of plants by asking local assistants their uses while measuring trees in the smaller inventory plots (10 metre radius). These were collated into a customary plants data base held at the Herbarium in Honiara. It seems that most rural people are able to identify common natural medicinal plants, however specialist traditions may be dying out.

Handicraft Materials

These include carving timbers, fibres for basket and other weaving, bamboos, fishing materials, tools, and materials for customary artefacts. (The latter include decorative and other materials such as household utensils, dyes, body ornaments, perfumes, garden plants, ceremonial plants, weapons, and materials for traditional musical instruments such as pan pipes, drums, rattles etc). These materials are likely to be gathered close to the village, and generally seem to be as easy to find as in the past.

Building Materials

Rural people are directly dependent on the forest for their building materials: roof thatching (sago palm etc), battens, pins for holding the thatch to the battens, rafters and beams, studs, wall materials (often woven bamboo or rattan) flooring, joists, poles, decorative carvings, and vines to tie house frames together.

Rattans (lawyer vines) are collected for local use and for sale to provincial and Honiara-based furniture manufacturers with some unprocessed rattan being exported. There is therefore a good opportunity to grow rattans as cash crops as well as for local consumption.

Canoes

Larger wooden canoes are made by hollowing out a large log of one of several tree species (usually *Gmelina moluccana*). An alternative to the larger wooden canoes are the fibreglass canoes manufactured in Honiara, but so far there is no substitute for the small one-person dugout canoes

which are commonly used by women and children. Trials should be made of other species (eg. *Gmelina arborea* which can grow very rapidly under the right conditions) to make into the smaller canoes.

Animals, Insects, Plants for Sale

Recently, the wildlife trade has earned up to SI $2 million in export earnings per year. Most of this comes from exporting live birds. Probably this trade is not sustainable, and there seem to be good opportunities to breed wildlife for sale, including butterflies and crocodiles.

Small Scale Logging, Milling and Charcoal Making

At the time of the inventory, 11% of the villages had portable sawmills, and 61% had chainsaws, with an average of two in these villages. About 25% of the villages reported that they extracted and sold timber from the natural forest.

Portable sawmills provide local employment for their owner-operators, casual work for villagers, and a return to the resource owners from the sale of the sawn timber. More importantly, such operations ensure that the resource owners remain in control of their forest resources.

A related activity is charcoal making, which is common on Guadalcanal, where nearly half the villages said they were involved, but practiced by less than one third in other areas.

2.5 EFFECTS OF COMMERCIAL LOGGING

As can be seen from Table 2.3 most of the benefits that are traditionally expected from large scale logging operations had been received. Questions were not asked about the use of facilities established by the companies, such as health care and access to stores and fuel supplies, but these are usually made available to local people.

TABLE 2.3
BENEFITS FROM COMMERCIAL LOGGING

	Expected	Received	
	% for those asked	% for those whose expectations were surveyed	% for all cases
Royalty money	100	95	96
Employment	100	100	96
Roads	80	45	46
Clearing of gardens	20	20	21
Firewood	15	20	32
Timber for village use	25	20	21
*Replanting of forest	30	15	15

* NB Only 20 out of 28 villages were asked about replanting of forest.

Problems were experienced in all regions as a result of logging, but particularly on Guadalcanal (this may be the result of one or two companies' operations). All of the villages which reported problems referred to damage to streams, most of which were important local water supplies. Soil damage and erosion, resulting from poor logging practices involving the use of heavy machinery (bulldozers in particular) were also widespread. Damage to gardens, tambu sites and mangroves was reported also. Table 2.4 summarises the reported problems associated with commercial logging.

TABLE 2.4
PROBLEMS THAT ARE ASSOCIATED WITH COMMERCIAL LOGGING

Problems	% of "logged" villages which responded
spoilt streams	100
soil damage	92
fewer building materials	80
land disputes	80
less wildlife	72
damage to gardens	68
tambu sites disturbed	60
damage to mangroves	20
other problems	64

Land disputes are common and usually arise during the process of entering into a logging agreement. Such disputes are often referred to Local Area Councils for arbitration, however disputes and grievances can linger and result in severe social disruptions.

2.6 ATTITUDES TO FOREST DEVELOPMENT

Responses to forest development options are summarised in Table 2.5 below.

TABLE 2.5
RESPONSES TO FOREST DEVELOPMENT OPTIONS*

Development options	% "Yes"	% "No"	% "Maybe" or "do not know"
logging by timber company	6	68	26
small scale logging or sawmilling by landowners	83	0	16
plantation forestry by timber company	3	88	9
plantation forestry in joint venture with company	14	55	31
plantation forestry by land owners	60	8	32
cash crop development by plantation company	3	92	5
cash cropping by land owners	78	6	16
tourism run by outside company	5	87	8
village owned tourism project	45	14	41

*note: due to changes in the village questionnaire this data was collected from only 116 villages

It is clear from Table 2.5 that developments which involve outsiders are generally not acceptable to the Solomon Island villagers, an attitude that is consistent through the country. All regions were more or less equally well disposed to small scale logging by locals and, with the exception of Rennell, this was the most approved form of these development in all regions.

The inventory found that small scale sawmilling is becoming increasingly important in the Solomon Islands. Much of this milling is being done by the local resource owners at their own initiative using four types of mill including the Solomon Islands Development Trust's

(SOLTRUST) "walkabout sawmill", the chainsaw powered "alaskan" mill, the New Zealand designed Peterson mill, and the Australian "Dynasaw" mill. The exact number of mills operating in the Solomon Islands is not known, however, in 1992 the Forestry Division estimated that, based on sales of equipment, there were about 1,200 portable sawmills scattered throughout the Solomons.

Eleven percent of the villages in the survey had portable saw mills. In addition, 61% of villages had chainsaws with an average of two chainsaws each. Although most of these chainsaws are probably being used for domestic purposes such as garden clearing and firewood cutting they could also be used for small scale logging and milling.

There are mixed views about the value and impact of small scale sawmilling. On the positive side, these operations can provide regular employment for their owner-operators and for villagers. They also meet the strongly expressed need of Solomon Islanders to control the utilisation of their own resources and return any profits from the sale of logs to the resource owners.

On the negative side the quality of timber produced is poor and the resource (the tropical hardwood forest) is therefore being devalued. In addition, the uncontrolled proliferation of chainsaws and small mills may be having an impact on the environment. These scattered and localised impacts, when considered cumulatively, could be significant. Also, the operation of portable sawmills has not been shown to be economical, especially if all capital costs and depreciation are considered, at least for utility timbers rather than high value timbers.

The Alaskan mill, which requires a smaller capital outlay, is more likely to be profitable in spite of its high operating costs, and the impossibility of producing high quality products (these would require re-processing at a central collecting point).

There is no doubt that, for local people, the attraction of small scale logging and sawmilling is that it is an appropriately scaled form of development with affordable initial outlays that enable them to utilise their own resources independently of outsiders.

Knowledge of the Effects of Deforestation

Although interested in development, the people attending the village meetings were very concerned about the effects of deforestation. They felt environmental problems would be severe, and some commented that these would lead to social and economic problems. They would lose their access to wild food plants and the small animals and birds that they hunt, as well as finding it difficult to make gardens because the land would be spoiled by erosion and the streams would dry up or become polluted. Materials for houses would also be difficult to find and pollution of the sea as a result of erosion would cause damage to reefs and marine life. Climate changes, loss of shade and fresh air, leading to higher temperatures were also anticipated. Pressure from physical problems might even lead people to leave the area.

People certainly expected that the coming generations would lose the quality of life they currently enjoyed. Social problems foreseen included disruption from logging company employees from outside their area, loss of lifestyle, boundary disputes and arguments. Destruction of tambu sites was also of concern.

There was little difference among the regions in the responses to loss of all primary forest.

From the nature of the responses, including the recurrence of particular phrases when answering the questions, the recent awareness campaign conducted by the Solomon Islands Development Trust (SIDT) has been most effective.

The Need for Integrated Resource Management

The inventory's geographical information systems (FRIS and NATRIM) have provided a method for integrating resource information. The sociological study indicated that resource management capabilities, involving the assessment of resources, planning, impact assessment, and monitoring, using these systems need to be developed and implemented urgently.

Such an approach would assist land owners to plan the best long-term use of their land for food production, hunting, fishing and gathering, tree harvesting, cash cropping and so on. A Resource Management Unit should be set up by SIG to prepare guidelines for an integrated approach to the development of customary land, to advise Provincial Governments, SIG agencies and non government organisations (NGOs) on resource management approaches to land use planning, and to provide technical assistance. At present a planning capability is being developed within the Forestry Division and this could complement the work of such a unit, including sharing the FRIS data.

Legislation and Land Registration

Many recent missions examining the forestry sector in the Solomon Islands have raised the need for legislative reform. Additionally there is widespread ignorance among resource owners about the existing legislation and their rights, which, combined with rural poverty and a lack of sophistication in commercial matters, creates a situation which has lent itself to exploitation. In addition, as pointed out in Working Paper No. 2, the confused legislative situation and institutional weaknesses prevalent in the Solomon Islands are conducive to malpractice. Clearer definition of responsibilities and roles, better planning and more realistic procedures at all levels are required.

Solomon Islanders see individual registration of customarily owned land as an abhorrence. By and large customary ownership functions well for individuals and communities when not faced with economic development or changes in land use. However, conflicts over ownership flare up in most economic development situations. These are stressful for the whole community, and severely retard development efforts at local levels. Legislative changes to encourage the recording of clan land boundaries and to permit areas of clan land to be individually leased would greatly reduce ownership conflicts and would facilitate good forest management.

Advice to Land Owners

Although the process of gaining agreements to log forests is laid out in legislation, land owners are generally ignorant of the formal approval processes, their legal rights, and the obligations of logging companies. Although the inventory and the Timber Control Unit in the Forestry Division have been involved in educating land owners on the provisions of a Standard Logging Agreement, much more work is needed in this direction. To ensure that land owners have access to advice on logging agreements, SIG could provide additional resources to the Office of the Public Solicitor, and mandate that office to develop and provide legal advice on forestry in all provinces where large-scale logging is taking place.

LAND RESOURCES AND THEIR SUSCEPTIBILITY TO DETERIORATION

3. LAND RESOURCES AND THEIR SUSCEPTIBILITY TO DETERIORATION

3.1 PHYSICAL RESOURCES

The Solomon Islands lie at the zone of convergence of the India-Australia crustal plate which is moving northwards, and the Pacific plate, which is moving westwards (Falvey, et al, 1991). About 10 million years ago a section of the Indo-Australian plate was torn away, and the plate began to be subducted beneath it. To the east, the Pacific plate began to ramp up onto the torn-away section. Portions of both these crustal plates emerged from the sea to form islands.

This theory explains how three different major "geological provinces" have developed in what is now the Solomon Islands. The **Pacific Geological Province,** represented by Malaita, Ulawa and the north eastern part of Isabel, is formed on the Pacific crustal plate. The **Central Geological Province** runs through Makira, Guadalcanal, the Floridas, the south western portion of Isabel and Choiseul, and is formed upon the detached portion of the India-Australian crustal plate. The **Volcanic Geological Province** includes the volcanic islands of New Georgia, the Russell Islands, the Shortlands, the north western tip of Guadalcanal and Savo Island. The main islands are thus related to three quite different geological regions, which explains differences in the botanical composition of their forests and differences in their geology.

Two smaller geological provinces, have also been recognised, the **Oceanic Volcanic Province** which includes the islands of Temotu Province (structurally, however, these are connected to the Vanuatu group of islands, rather than to the other parts of Solomon Islands) and the **Oceanic Atoll Province** which includes the uplifted atolls of Rennell, Bellona, Ongtong Java, etc.

The major geological provinces or regions of the Solomon Islands are shown in Map 3.1.

All of the Solomon Islands are geologically young and dynamic compared with more ancient and stable land masses such as Australia: the Solomons have high rates of geological uplift, active seismicity, an erosive climate (rainfall) and susceptible geological materials. As a result, rates of natural erosion are high and many of the rivers have naturally turbid water, even though very resilient tropical forest blankets most of the country.

The **soils** of the Solomon Islands were described by Hansell and Wall (1974-6) during a land resources study of the Solomon Islands. They were classified according to the United States Department of Agriculture's Soil Taxonomy (USDA, 1973) and a soil association map was prepared at 1: 250,000 scale, based on land system boundaries. From this essentially "detailed reconnaissance" survey and additional information gathered by the Ministry of Agriculture and Lands, a large amount of soils information has been produced.

The soils that occur in each province and their classification, parent materials, landform and fertility are given in the relevant regional volumes.

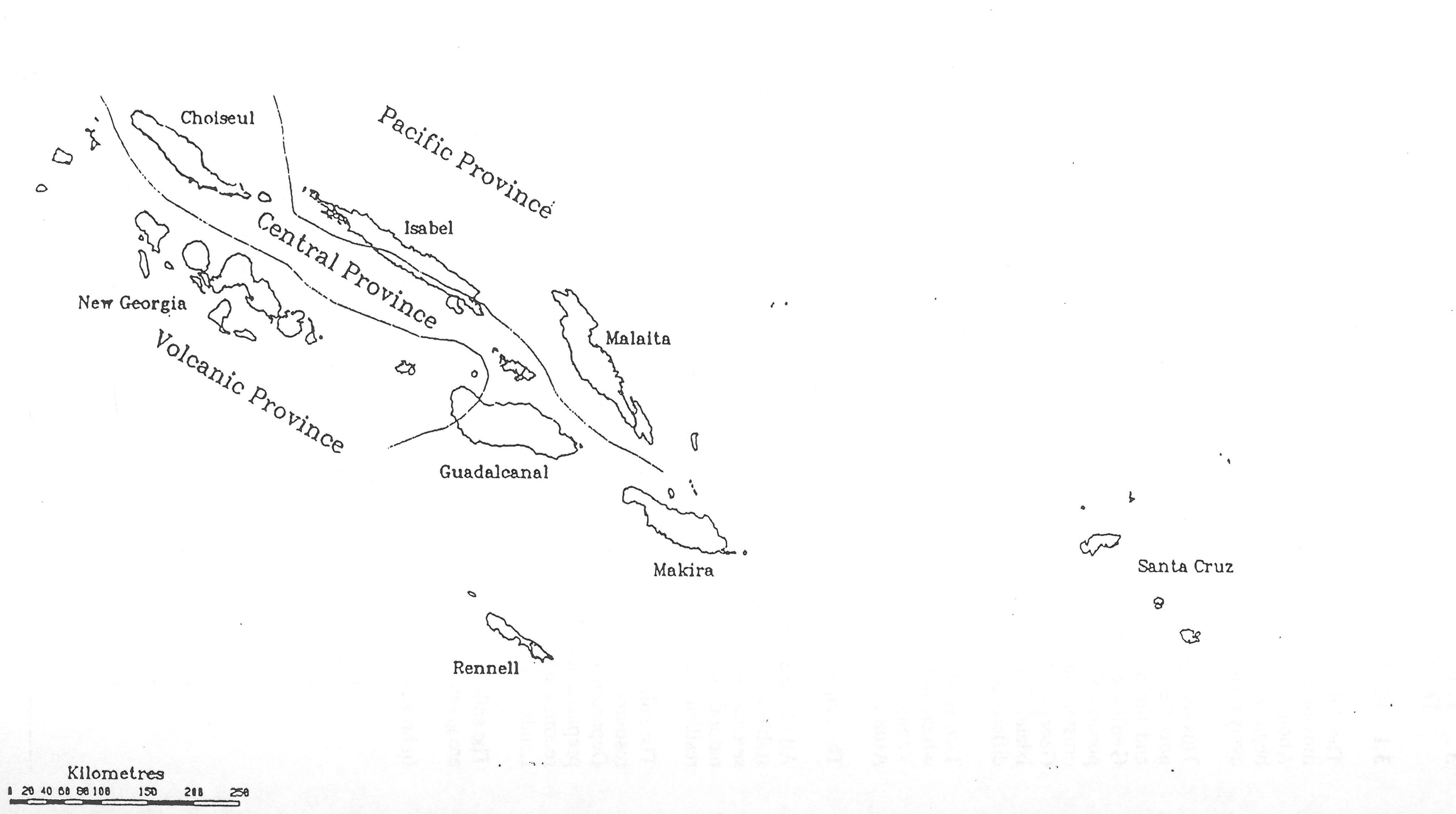
In broad terms, tropical forest soil profiles have three main strata.

> An **organic mat** (litter layer) of fallen leaves, etc. offers protection from the impact of rain on the mineral soil below and acts as a sponge that promotes infiltration. This decomposed mat is also an important nutrient store so that with these three functions, it is a most important part of the Solomon Island forests.
>
> The **topsoil** which is up to 30 cm deep, is friable, quite strongly structured and permeable, with good levels of calcium and magnesium but low levels of potassium and phosphorus.
>
> The **subsoil** is usually acid heavy clay with less structure and a low permeability. Nutrient levels here are very low and the mineral clay complex is dominated by aluminium.

MAP 3.1

Geological Provinces

Solomon Islands National Forest Resources Inventory



Generally, the more stable sites with low relief where soil weathering has been able to proceed for longer periods have deep topsoils with acid subsoils, and low levels of fertility (Oxisols or Ultisols). Nutrient cycling is important in maintaining fertility in these tropical forest soils; if they are cleared, residual nutrient levels are often too low to sustain alternative land uses such as subsistence agriculture.

Freely drained brown loams and clays (Inceptisols) formed on basalt or other basic rocks are younger, less weathered, more fertile soils and are preferred for subsistence agriculture. These have often been formed on relatively steep slopes where rates of natural erosion are higher. Soils which have a dark organic topsoil (Mollisols) are also favoured.

Land systems were identified and described for all parts of Solomon Islands by Hansell and Wall (1974-76). (A land system is an area of land, distinct from surrounding terrain, within which there is a characteristic pattern of geology, landforms, soils, and native vegetation.) These land systems have been grouped into land regions and may be scattered rather than single blocks. The land regions were used by Hansell and Wall as units to determine agricultural potential.

Within each land system several sub-units termed "land facets", have been recognised. These are relatively simple areas of land occurring on a particular substrate and with soil and water regimes that are uniform, or at least vary in a simple and consistent way. Each is sufficiently homogeneous to be managed uniformly for all but the most intensive forms of land use. The land facets were described in terms of their landform, soils, vegetation and land use but they were not mapped, which would have required a much more intensive field survey and a considerably smaller map scale, if accepted standards of reliability were to be met.

The land system and land facet information has been valuable as a data base for several aspects of the inventory, especially in determining the susceptibility of lands to various forms of deterioration, the likely impact of different forms of land use, areas potentially worth conservation, and potential sites for forest plantations ["Plantation Opportunity Areas" (POA)].

3.2 REQUIREMENTS FOR PROTECTION

Land resources need to be protected - to ensure that their utilisation is sustainable, and to protect socioeconomic or conservation values.

In the case of sustainable utilisation (or productivity) appropriate management guidelines need to be devised, policed, and enforced if necessary. These guidelines need to be specific for particular forms of land use, such as mechanised agriculture, mining, logging, plantations, and subsistence agriculture (in some cases).

Where commercial or subsistence utilisation of soil or forest resources occurs, **management guidelines** need to take account of the inherent susceptibility of the land to deterioration: lands with a naturally high rate of erosion, which are more susceptible to both on-site and off-site damage if disturbed, should be managed more carefully to take account of the greater susceptibility to erosion. Information on land facets and land systems derived by Hansell and Wall (1974-76) would be a good starting point for such management guidelines.

If a catchment (an area in which all water drains to a common exit point) supplies domestic water or a hydropower dam or includes an area worthy of conservation, the land upstream from those features may need protection. On the other hand, if mangrove areas, coral reefs, or near-shore fisheries are to be protected, land use in the whole catchment may need to be controlled.

It may be possible to utilise soil or forest resources that occur in these upstream areas if special protection measures are observed. Proposals to utilise these protected areas should be accompanied by an environmental evaluation, and proceed only according to appropriate management guidelines drawn up to protect the feature concerned (see Table 3.1).

Because insufficient information is available on land capability or appropriate management, only general protection measures have been recommended by the inventory. There is a need to confirm and refine the assessments of agricultural potential made by Hansell and Wall (1974-76) and to clearly differentiate between hazards to land resources (such as the likelihood of soil erosion or loss of fertility) and the factors likely to limit agricultural land use (such as poor soil drainage, low pH or inadequate soil moisture-holding capacity).

The ***soil and water resources*** of the Solomon Islands are protected by intact tropical forests which also sustain them, as they also recycle nutrients. The forest canopies intercept heavy rainfall so that it falls more gently onto the organic mat or litter layer, promoting infiltration and protecting the soil against erosion. Surface roughness and topsoil permeability also promote infiltration, so that water moves to deeper levels until it re-emerges as springs, maintaining baseflow in streams for longer periods and reducing surface run off. Tree roots also physically bind the soil and protect it from erosion and landslides.

Logging, unless it is properly controlled, can result in irreversible damage to the site. If logging is poorly planned or poorly controlled, the soil on as much as 50% of the area can be affected. In the worst cases the organic mat and the topsoil are removed or compacted so that little undisturbed soil remains. This results in the loss of friable rooting media, seedlings, soil nutrients and permeability. In tropical forest soils where nearly all of the nutrients are in the top 30 cm of the soil, this loss, even if the soil as a whole is very deep, is serious.

Nutrient loss in the removed biomass through the litter layer is more serious on the deeper, more strongly weathered soils where nutrient cycling is a dominant process.

Until a cleared site is completely re-vegetated, soil erosion adds to the damage. Where subsoils have been exposed, especially the dense, very acid subsoils such as those of Oxisols and Ultisols, re-vegetation may not occur for a decade or even longer. Meanwhile soil erosion continues and the site is further impoverished.

Increased runoff and decreased infiltration reduce baseflow in streams and lead to increases in flash flooding, sedimentation and turbidity.

Compaction is another problem. Tropical forest soils are very susceptible to compaction especially when they are wet (as they usually are). Heavy machinery closes soil macropores, especially with repeated passes in the same tracks, and the damage is almost irreversible under natural conditions. To rehabilitate sites which are badly compacted, such as log dumps and secondary logging roads, ripping to at least 30 cm is recommended, top soil should be stockpiled and returned to the sites wherever practicable. Cross-drains should be constructed on roads and tracks and logging roads must be "put to bed" (restored) after logging has finished.

It can be seen, therefore, that poor logging practices can result in degradation of the site for generations, if not forever.

Apart from the effects of heavy machinery making repeated passes over minor logging roads and snig tracks, poor alignment of roads and tracks and logging close to streams cause lasting damage, particularly to fresh water supplies. In the worst cases, heavy siltation can damage marine environments as is happening at Roviana Lagoon in Western Province (see Working Paper 12).

3.3 THE LAND SUSCEPTIBILITY CLASSIFICATION

Land systems, which are defined in terms of geology, landform, soils and native vegetation, have been used as classification units rather than catchments which may not be uniform throughout and may have large variations in geology, landform, soils and native vegetation within them. (However, catchment boundaries can be overlaid upon the maps which are based on land systems so that the actual distribution of susceptible land areas within each catchment can be easily seen).

In classifying land where logging operations may occur, the most important factor is the inherent stability of the land. This is determined by the nature of the rocks, soils, slopes and other factors within the area.

The inherent stability of an area of land is best measured by its susceptibility to deterioration if it is disturbed. However, there is no way of measuring this directly, consequently, various indicators of potential instability were considered: steepness, length of slope, seismicity, relief, the inherent susceptibility of the geological materials to erosion or structural failure, land system and land facet descriptions, and an independent assessment based on recent aerial photography. Influences such as seismic activity and climate, especially rainfall and rainfall intensity, are also important but they do not depend on the type of land. In the land classification used here, all of these factors have been taken into account.

As a first step, the above indicators were used to classify lands into "relatively susceptible" or "relatively stable" classes.

As a second step, climatic and seismic data were superimposed on these two classes. Very little rainfall intensity information was available so rainfall quantity was used to approximate a "relatively erosive" rainfall class and a "less erosive" class.

Seismic activity in the Solomon Islands has been well documented and areas of relatively high activity and relatively low activity were easily identified.

When all three factors (inherent susceptibility, seismic activity and rainfall) were integrated, five classes of susceptibility of land to deterioration were obtained. These are shown in Table 3.1.

Using the FRIS/NATRIM data base, land systems having each susceptibility class were identified and agglomerated as necessary. The results are shown in maps in each regional report, and the areas of the Solomon Islands found by this system to be most susceptible (S_4 lands) are shown in Map 3.2. S_0 (least susceptible, most stable) to S_4 (most susceptible) areas are shown on Maps in the regional reports . A fuller explanation of the classification is given in Working Paper 12 (Aldrick, 1993).

TABLE 3.1
LAND SUSCEPTIBILITY CLASSES

Map symbol (susceptibility rating)#	Inherent susceptibility of land systems to deterioration (high *, low -)	Degree of seismic activity (high*, low-)	Erosivity of climate (high*, low-)
S_0	-	-	-
S_1	-	*	-
S_1	-	-	*
S_2	-	*	*
S_2	*	-	-
S_3	*	*	-
S_3	*	-	*
S_4	*	*	*

Use of the Susceptibility Maps

Because they have been entered into the FRIS and NATRIM computerised data bases, the maps showing the susceptibility of the land to deterioration can be used for a variety of purposes by overlaying this information on other sets of information, eg. to make a composite map of susceptible lands and ecologically significant forests. A "land condition" factor could be generated by computer for any site from the urban, agricultural, logged and degraded forest categories delineated from air photo interpretation and this could be superimposed on other information.

Resource use options could also be superimposed on the susceptibility maps. For example, areas of forest suitable for logging could be plotted by computer and any forests occurring in susceptible areas identified and scheduled for more rigorous management constraints and controls, see Chapter Five of the regional reports where examples are described.

Similarly, features with a high environmental significance or conservation value, or important water catchment areas could be overlaid on the susceptibility maps to indicate the degree of protection they may require. Sensitive off-shore features such as fisheries, mangrove areas, and coral reefs could be plotted and seen in relation to the susceptibility of adjacent catchments with the attendant possibility of an influx of sediment and other pollutant (see Chapter Five of the regional reports).

In these ways, the protection needs of lands to be allocated to specific uses can be determined. Appropriate land management guide-lines can then be formulated and applied to help ensure sustainable forms of land use and the maintenance of land resources in a sound condition.

MAP 3.2
LANDS THAT ARE MOST SUSCEPTIBLE TO DETERIORATION

THE NATURAL ENVIRONMENTS OF THE SOLOMON ISLANDS

4. THE NATURAL ENVIRONMENTS OF THE SOLOMON ISLANDS

4.1 INTRODUCTION

Many different values have to be considered when identifying and describing the non-timber resources of the Solomon Islands forests. These include: water quality, customary uses, rare and endangered species of flora and fauna, genetic diversity, and ecological processes. A preliminary assessment by the inventory indicated that the current information base was patchy in both extent and quality: it was inadequate to describe these values. It is also important that this information is uniform if it is to be to used describe the Solomon Islands in terms of its flora and fauna so that comparisons can be made region by region, in a national context.

Therefore the inventory set out to obtain more accurate information so that landowners and governments can make better resource management decisions, including the identification and conservation of representative samples of important ecosystems, which is a most important aspect of forest management.

The ecological information gathered by the inventory was used to:

- identify, describe and map the major ecological domains of the Solomon Islands in a uniform manner, (ecological domains are areas of land with similar *physical* environmental characteristics, eg., climate, topography, landform, geology, soil).

- describe the botanical structure and floristic of the forests that were sampled to provide a better understanding of them;

- identify major centres of biodiversity and areas of particular biological significance, including those likely to be affected by forest utilisation (eg mangroves, riverine communities, swamps, seagrass beds, predicted or known locations of rare or endangered species);

- identify areas which governments should consider for some form of protection to conserve special features;

- identify places where constraints need to be applied to large scale logging or clearing operations in order to conserve either the areas themselves or downstream habitats such as coral reefs, swamps and mangroves which are important marine resources.

This data should also be used when preparing logging plans, to identify areas where special precautions have to be taken to avoid environmental damage.

Generally, the current rates of logging cannot be sustained and are resulting in the substantial and irreversible modification of unique features of the Solomon Islands environment. Given the virtual absence of viable and secure conservation reserves in the Solomon Islands, this is of particular concern.

It should be noted that the environmental and ecological work of the inventory including the identification, mapping and description of major ecological domains was not the primary focus of the project design and as a result was constrained by limitations on field work and difficulties in identifying plants.

4.2 BIODIVERSITY AS A BASIS FOR CONSERVATION

Biodiversity is defined as "the variability among living organisms from all sources including diversity within species, between species and of ecosystems. It provides resources for the development of new products (including cosmetics and pharmaceuticals) research and education, recreation, tourism and the development and improvement of crops and livestock. Biodiversity is important for the regeneration of harvested resources, for the maintenance of ecological processes (such as stabilisation of climate, protection of watersheds and renewal of soils) and is regarded as a vital part of world heritage.

Others state that biodiversity is the source of all biological wealth, and point out that all societies, urban and rural, rich and poor, continue to draw upon a wide variety of ecosystems, species, and genetic variants to meet their needs for goods and services.

The biodiversity of island environments and the ways in which they evolved, have produced many varied ecosystems in the Pacific, which provide or maintain the natural resources upon which island communities depend. However, island ecosystems tend to be fragile and easily disrupted or degraded, as demonstrated by trends in many parts of the Pacific.

In the Solomons, there is a high degree of endemicity (plants and animals that occur on a particular island and nowhere else are termed "endemics") so that any substantial loss of habitat is likely to lead to the extinction of species of flora and fauna.

It is also of interest to those concerned with the management of the natural forest resources of the Solomon Islands that the World Conservation Union (IUCN) has listed both oceanic islands and tropical moist forests among the most threatened ecosystems in the world.

Much of the land development and utilisation of natural resources in the Solomon Islands has been concentrated in the coastal lands which are generally narrow (except in the case of northern Guadalcanal). As a result many of the lowland vegetation types are now much reduced in area or highly modified by subsistence gardens, coconut plantations, etc. This is of concern because logging and further plantation development tend to concentrate here.

4.3 ECOLOGICAL BACKGROUND TO THE SOLOMON ISLANDS

The Solomon Islands, which consist of a double chain of islands along a north-west south-east axis, are spread over some 1,400 km with a land area of about 28,000 square kilometres. The Pacific "volcanic rim" contains part of this chain and there is a general susceptibility to earthquakes with a number of active and dormant volcanoes most of which are submarine.

As noted in Chapter Three, the Solomons occupy three main geological provinces, a Volcanic Province containing the Shortlands and the other islands of the Western Province, Russell Islands and the north east part of Guadalcanal, a Central Province and a Pacific Province (see Map 3.1.).

Temotu which is structurally part of the Vanuatu group of islands is part of a smaller Oceanic Volcanic Province and an Oceanic Atoll Province includes the uplifted atolls of Rennell, Bellona, Ongtong Java, etc.

This geology influences the distribution of the Solomon Island plants and animals and leads to differences between the island groups with islands from the two Volcanic Provinces and the Atoll Province being markedly different from the others.

Many of the Solomon Island species and varieties of fauna and flora are endemics (occur nowhere else in the world) and are of international significance. Of the 163 species of land birds that breed in the Solomons, 72 species, or 44%, are considered to be endemics. A further 62 species (38%) occur elsewhere but are represented in the Solomon's by unique races or subspecies.

Diamond (1976) claimed that there is no other place in the world, not even in the Galapagos Islands, where the biological phenomenon of speciation and of population variation between islands is so marked as in the Solomons.

Further evidence of the unique nature of the Solomon Islands fauna and Flora is provided by a recent review of the protected areas system in the Pacific by Dahl (1986). This ranked 223 islands by their conservation significance, placing Rennell 8th, Guadalcanal and Makira equal 13th, and Malaita 30th.

Knowledge of the distribution of mammals in the Solomon Islands is very incomplete (Flannery, 1990). However, it is known that the mammal fauna, which is mainly limited to bats and rats, includes several species which are endemic to Solomon Islands and that many of these animals are dependent on undisturbed rainforests.

Although relatively little broad-scale ecological study has been undertaken on the forests of the Solomons (particularly in the less accessible parts) Whitmore (1974) and Marten (1985) provide insights into species patterning, biomass, and forest zonation, and the Maruia Society has listed birds found in the forests and has proposed forest areas for reservation (ANPWS, 1991).

There is a pattern of decline in the number of plant species as one traverses from PNG to Western Samoa which is noticeable within the Solomons, with species common in the west (such as *Campnosperma brevipetiolata*) being absent from Guadalcanal and Makira, while some species from further east, such as *Terminalia brassi* and *Calophyllum kajewskii* are absent from the Santa Cruz Islands (which however contain the Solomon Islands population of Santa Cruz Kauri - *Agathis macrophylla*).

Some differences between tree species occurring on the different islands are listed in Chapter Five.

4.4 METHODOLOGY OF THE ENVIRONMENTAL AND ECOLOGICAL SURVEY (EEFS)

4.4.1 Selection of Stratified Catchments

This formed the basis of the ecological input to the design of the sampling of catchments for field survey in each region. This was considered to be a critical component of the EEFS since it identified key elements of biological diversity which will be required to be adequately sampled during the field survey work. Where suitable (ie. recent, large scale) aerial photography was not available prior to the design stage for each of the regional surveys, satellite imagery (SPOT or TM depending upon availability of recent cloud free imagery) was used to identify broad environmental diversity. Where the aerial photography is more than three years older than the available imagery, the imagery, wherever possible, was used to update forest cover and condition as mapped from the older photography.

4.4.2 Environmental and Ecological Characteristics

Much of the data to achieve this objective came from the timber and environmental field surveys. The primary unit sampling design included the broad range of environmental domains identified by ERMS. There was additional data recording outside the timber survey transects to ensure sampling of other important ecosystems.

The ecological and environmental field survey was not a separate survey from the Forest Field Survey (FFS) but operated as a complementary programme largely operating within the sampling design of the FFS, together with data collection from some additional sites and utilising different forms of information gathering. In fact, it was seen as essential that it largely utilised the same base as the FFS since its main purpose was to act as a major layer in the FRIS providing information on the ecological and environmental constraints upon various forest resource utilisation options (primarily, but not only, commercial logging).

The field crews were comprised mainly of Solomon Island nationals who undertook an intensive training programme, designed and co-ordinated by the Environmental and Ecological Specialist, prior to field survey.

They sampled a sub-set of the field plots surveyed by the Field Timber crews, and utilised local village knowledge of the resources of the forest to collect data on resource values. The EEFS teams also conducted the village interviews which yielded most of the sociological data collected for the project. During their stay in villages they used the bird identification sheets produced by the Ecological Specialist to record information on avifauna. They also spoke to village people about any unusual animal sightings in the area.

4.4.3 Outputs from EEFS

Following collection and analysis of the field data, the following datasets were produced:

* collection of an extensive plot and catchment based database on native biota and forest resource use;
* Solomon Islands local language synonyms for a wide range of customary use species of plants and animals;
* mapping of ecologically sensitive areas (outstanding, high, moderate and low categories); and,
* identification of specific environmental constraints that will necessitate modification of timber harvesting practices.

The final output for each region included a comprehensive report on the ecological and environmental implications of forest resource utilisation together with a series of maps delineating:

* environmental domains
* areas of outstanding national and international biological conservation value where no commercial forest harvesting operations should be undertaken;
* areas where the basic physical environment (soils, water etc.) are so susceptible to degradation that logging operations should not be considered (this included steep slopes, erodible soils, location of watercourses, swamps etc)
* areas in which commercial operations could deleteriously affect outstanding ecological or physical environment values downstream (eg. seagrass beds), where only specially designed infrastructure requirements (eg. access roads) for commercial harvesting should be permitted; and,
* areas of little national, regional or local environmental or conservation significance where commercial operations can be considered under a national Code of Logging Practices.

A table of general forest types is presented at Table 4.1, and a list of the areas of outstanding biological conservation value is given in Table 4.2. The total area of the proposed reserves is 610,650 hectares or 22% of the land area of the Solomon Islands. It is appreciated that there is no legal system for reserving these areas at present in the Solomons, nevertheless it is considered that there is a very good case for some sort of reservation of these areas.

TABLE 4.1
GENERAL FOREST TYPES OF THE SOLOMON ISLANDS

TYPE	AREA (hectares)								
	Guadalcanal	Central	Malaita	Choiseul*	Isabel	Western Province	Makira	Rennell	Temotu
F	9692	2700	8165	10760	25216	39012	8776	280	200
FL, FN	408		2540			876	320		
H	347664	25925	266644	268984	295087	300824	253544	22788	53312
HL,HN	54272	12840	87900	17884	30580	50612	11922	332	3188
L	13980	5465	3552	5932	9168	28320	5040	37180	7076
LL,LN	44864	8081	16592		8644	24992	9956	2200	5564
U	51204	174	6612	704	10164	22044	11204		512
SM	1328	3112	9992	4144	17852	10544	908	188	2504
N	9880	84	2384	152	8215	18756	666	152	2936
cloudy	1040	128	1632	6976			7944	376	5236
TOTAL**	**534332**	**58509**	**406013**	**315536**	**404926**	**495980**	**310280**	**63496**	**80528**

KEY:
F: Freshwater swamps and riveraine forests
FL, FN: Freshwater swamps and riveraine forests (logged or degraded)
H: Hills rainforests, all types
HL,HN: Hills rainforests, mixed species (logged or degraded)
L: Lowland forests, mixed species
LL,LN: Lowland forests, mixed species (logged or degraded)
N: Non-forest
U: Upland or montane forests
SM: Saline swamp (usually mangroves)
SN: Saline swamp (usually mangroves) that has been degraded

* excludes Rob Roy and Vaghena islands (approx 15500 ha)
** The total will not agree exactly with the gross area of each province for several reasons, one being that not all islands were surveyed, another being that the individual areas were derived from the FRIS (ERM-S) which will not necessarily be exact.

TABLE 4.2
AREAS THAT SHOULD BE CONSIDERED FOR CONSERVATION RESERVES IN THE SOLOMON ISLANDS

Province	Location	* Area (hectares)	Total for each Province
Guadalcanal	Gallego	14000	
	Marau Sound	12000	
	Lauvi Lagoon		
	Aolo	18000	44000
Malaita	Central Highlands	35800	
	Maramasike	54900	90700
Choiseul	Mt Maetambe	27600	
	SE Choiseul	54800	82400
Isabel	Western Islands	79000	
	Mt Morescot	37200	
	San Jorge forests	22000	138200
Western Province	Western Vangunu	27800	
	Central Marovo	10000	
	Tetepare Island	11900	
	Hiriro Plateau	10600	
	Roviana karst & lagoon	19950	
	Mt Veve	17850	
	NW Vella Volcanics	11950	
	Sth Simbo Pyroclastics	500	110550
Makira	Bouro Highlands	41700	
	Western Wetlands	24900	
	Star Harbour	7900	74500
Rennell	East Rennell	22400	
	West Rennell	32600	55000
Temotu	Tinakula Island	1050	
	Lawrence River, Nendo	11000	
	SW Vanikoro	3300	
	Southern Utupua	1000	15300
TOTAL			**610650**

* Refers to the protection zone areas which are mainly over 30^0

THE FORESTS OF THE SOLOMON ISLANDS

5. THE FORESTS OF SOLOMON ISLANDS

Aerial photographs at a scale of about 1:25,000 were used to identify forest types but it is difficult to obtain cloud free aerial photographs of the Solomons because the skies are rarely clear and there is only a limited part of the day in the tropics when sun angles are suitable for effective photographs to be taken. In the Solomon Islands aerial photographs have been taken at many times (and at different scales) since the Second World War. However, older photographs usually do not depict the forests as they are now because the forests are subject to disturbances of various kinds and may be at various stages of recovery.

Some use was made of the 1:80,000 black and white photographs obtained in 1992 and 1993 by the Australian Defence Cooperation Project, particularly for "patching in" areas not covered by smaller scale photographs and deciding which areas had been logged. (Eventually these photographs will cover the whole country, since they are to be used to up-date the 1:50,000 topographic maps.)

The project could only use satellite imagery to a limited extent because cloud free scenes are difficult to obtain and because the scale of satellite images is too large.

In practice, it was found that 1984 aerial photographs were acceptable, but that 1979 photographs often proved difficult to work with. Any older photographs were of little use for our purposes because land use had changed or forests were more disturbed. Therefore, the inventory arranged for extensive areas to be photographed in 1991 and 1992-3; this photography was at a scale of 1:25,000 and in colour.

Maps showing the air photographs which were used are included in the regional reports (except Rennell, all of which is covered by 1993 colour photographs).

5.1 FOREST TYPES

A new classification of forest types was introduced by the inventory. This is capable of being extended by adding more types or more detail, eg. in the inventory of the Allardyce Tract, an extra item (regeneration) was assessed.

As the first step in making this new classification, "forest type" was defined as "any group of tree dominated stands which possess a general similarity in composition". The forest types can be areas dominated by a single species, **(such as freshwater swamp dominated by *Terminalia brassii*)** or a mixed species forest which has a distinctive character, such as **mixed species freshwater swamp** (where *T. brassii* may be present but not dominant).

In places where there is no natural tree cover, such as lakes and grasslands, "land cover types" are used.

Six basic forest types were identified, namely:

Saline Swamp Forest (*S*) occurs on lands subject to tidal and supra tidal influences such as estuaries and foreshores. **Usually these consist of mangroves.** On aerial photographs they are recognisable by their dense, relatively fine dark crowns.

Mangroves play a valuable role in protecting reefs because their stilt-like roots form effective sediment traps for eroded materials, whether the causes are natural or man-made. These forests also form a valuable resource for local communities, more, however, for their aquatic values than their wood values because they are usually limited in extent. Nevertheless their wood is useful for posts and poles and for firewood. It is important that mangroves are protected rather than being carelessly destroyed as so often happens.

Freshwater Swamp and Riveraine Forest (F) is common where there is little micro relief and drainage is impeded. On aerial photographs this type is recognisable by its topographic position and variation in crown size and density, and (in most of the Solomon Islands) by the presence of *Terminalia brassii* and sago palm. Where species like these are dominant, they are delineated as a separate type.

This type can contain important timber species, but requires careful logging practices (such as cable systems) to avoid damage to swampy sites.

Lowland Rainforest (L) on level or nearly level land has a complex structure and composition and is a variation of the better drained lowland rainforest that occurs on hills. Localised elements of freshwater swamp forests may be present.

This forest is characterised by the general absence of sago palm and *T.brassii*, except along river and creek banks, which is easily seen on aerial photographs. Several important commercial timber species are associated with this forest type which has often been converted to agricultural crops such as coconut plantations: there is therefore a good case for conserving some of the remaining forests of this type.

Hill Forest (H) occurs on well-drained sites. It is complex in composition and structure, and its appearance on aerial photographs varies considerably from place to place in crown size, colour, height, tone, and canopy density.

Hill forest forms the great bulk of forests with commercial potential in the Solomons. Often there are patterns that can be discerned on photographs which seem to be attributable to cyclonic disturbances and associated land slips.

A variant of this class of forest is dominated by *Casuarina papuana* which typically occurs on very alkaline ultra mafic soils, and can be identified on aerial photographs by its light tone and fine diffuse texture. *C. papuana* is not regarded as a commercial timber species.

Upland Rainforest On Hills (U) is a montane forest which occurs on higher altitude ridge tops and mountain summits, generally above 600 metres. Occasionally it is present at lower elevations in relatively harsher conditions. On aerial photographs this type is characterised by its topographic position and by its distinctive, dense and compact canopy with small light-toned crowns.

Steep slopes, low volumes and the Standard Logging Agreement which currently restricts logging to areas below 400 metres make commercial exploitation of this forest type difficult.

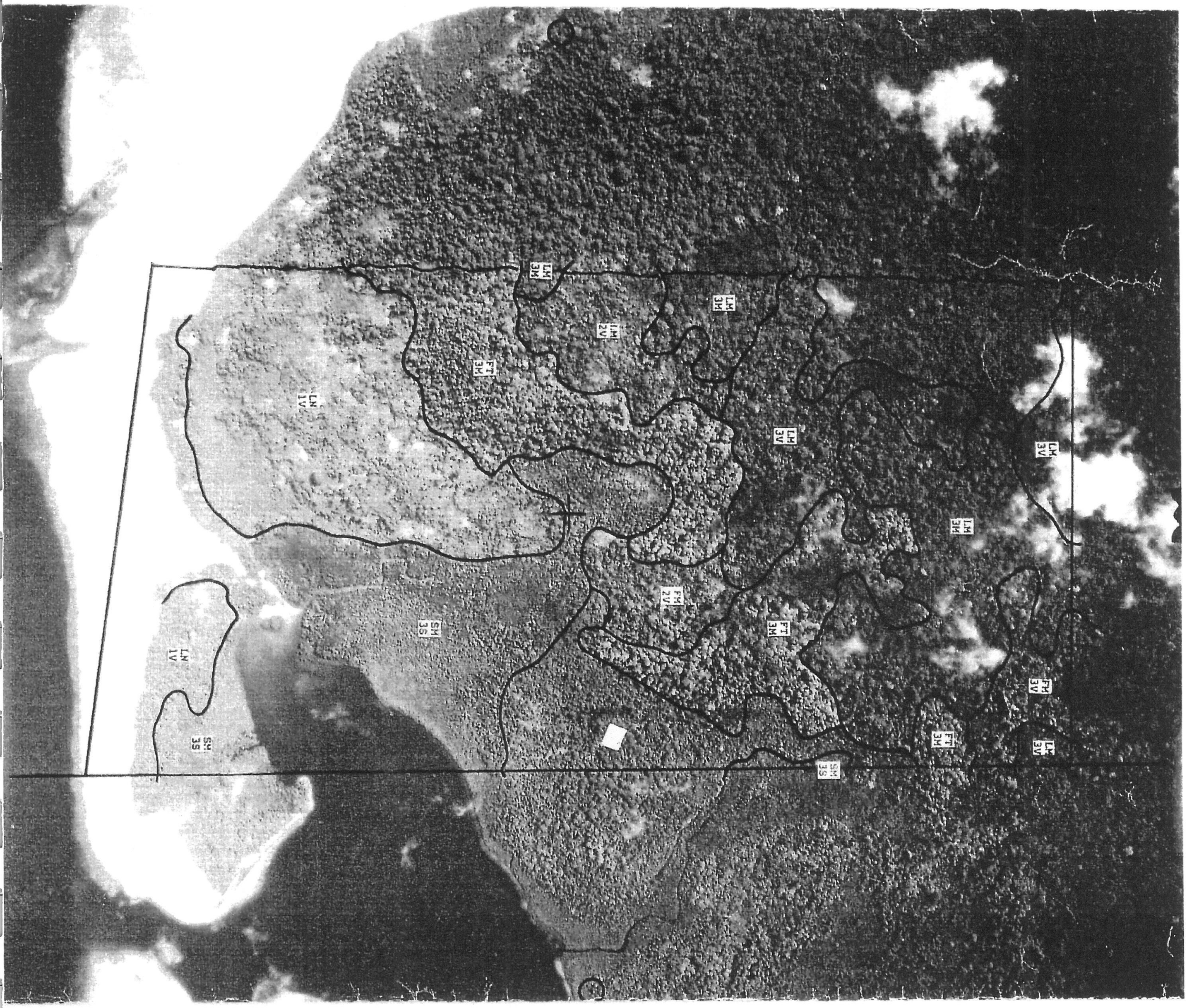
Non Forest And Other Areas (N) essentially comprise communities without a tree cover such as herbaceous swamp communities and braided river courses. Plantations established for timber production are also included in this type (these are delineated as one unit and no attempt has been made to dissect or classify them further into species groups).

The major forest types of the Solomon Islands identified by the inventory are listed in Table 5.1, and a copy of an aerial photograph of part of Choieseul with some of the commoner forest types is included as Figure 5.1.

Mapping of forest types in the traditional style (ie maps of all the Solomon Islands showing the forest types) was not attempted by the inventory: to produce useful maps, given the detailed nature of the forest typing, would be an immense and largely wasteful effort since maps can be produced "to order" from the NATRIM or FRIS data bases.

Examples of the maps that can be produced by NATRIM are given at Maps 5.1 and 5.2. Map 5.1 shows the detailed forest types on part of Pavuvu (Russell Islands). Map 5.2, of Bagha Island shows the forest types as amalgamated into commercial and semi-commercial forests. Maps of forest types, produced from the FRIS data base are included in each of the regional reports.

FIGURE 5.1
AERIAL PHOTOGRAPH OF CHOISEUL SHOWING COMMON FOREST TYPES



KEY TO FIGURE 5.1

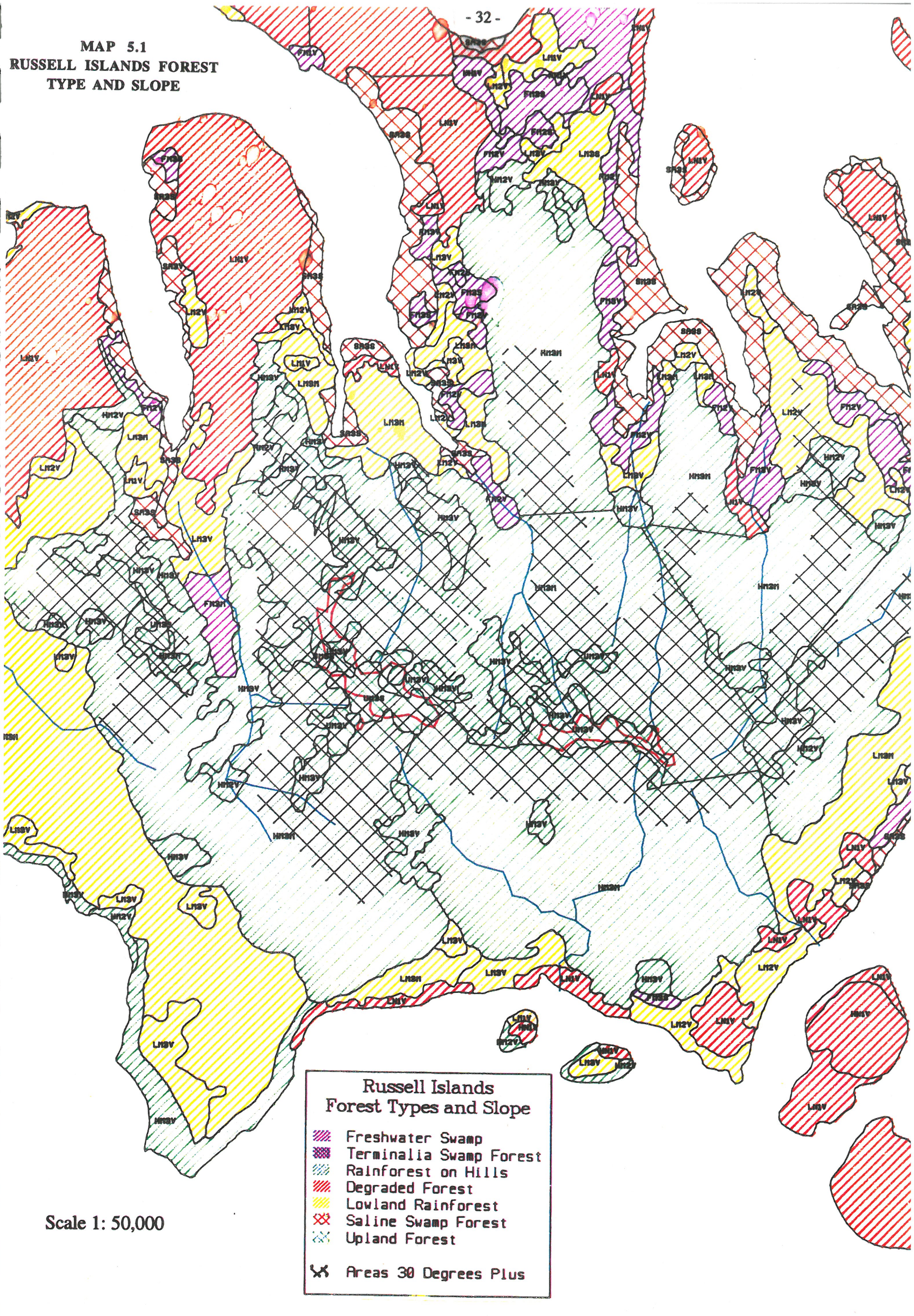
AIR PHOTOGRAPH OF PART OF CHOISEUL

Symbol	Description
SM 3S	Saline swamp forest, mixed species composition (mangroves dominant). Mid dense to dense primary canopy, essentially comprising small crowned trees.
FM 2V	Freshwater swamp forest, mixed species composition. Sparse to mid-dense broken primary canopy, comprising trees with various crown sizes. Usually severely to moderately disturbed.
FM 3V	Freshwater swamp forest, mixed species composition. Mid-dense to dense primary canopy, composed of trees with various crown sizes.
FT 3M	Freshwater swamp forest, dominated by Terminalia brassii. Mid-dense to dense primary canopy, essentially comprising medium to large crowned trees.
LN 1V	Lowland forest, severely degraded by anthropogenic disturbance. Cleared to sparse remnant forest of trees with various sized crowns.
LM 2V	Lowland forest, mixed species composition. Sparse to mid-dense broken primary canopy, composed of trees with various crown sizes. Usually severely to moderately disturbed.
LM 3V	Lowland forest, mixed species composition. Mid-dense to dense primary canopy, composed of trees with various crown sizes.
LM 3M	Lowland forest, mixed species composition. Mid- dense to primary canopy, essentially composed of medium to large crowned trees.

TABLE 5.1
MAJOR FOREST TYPES FOUND IN THE SOLOMON ISLANDS

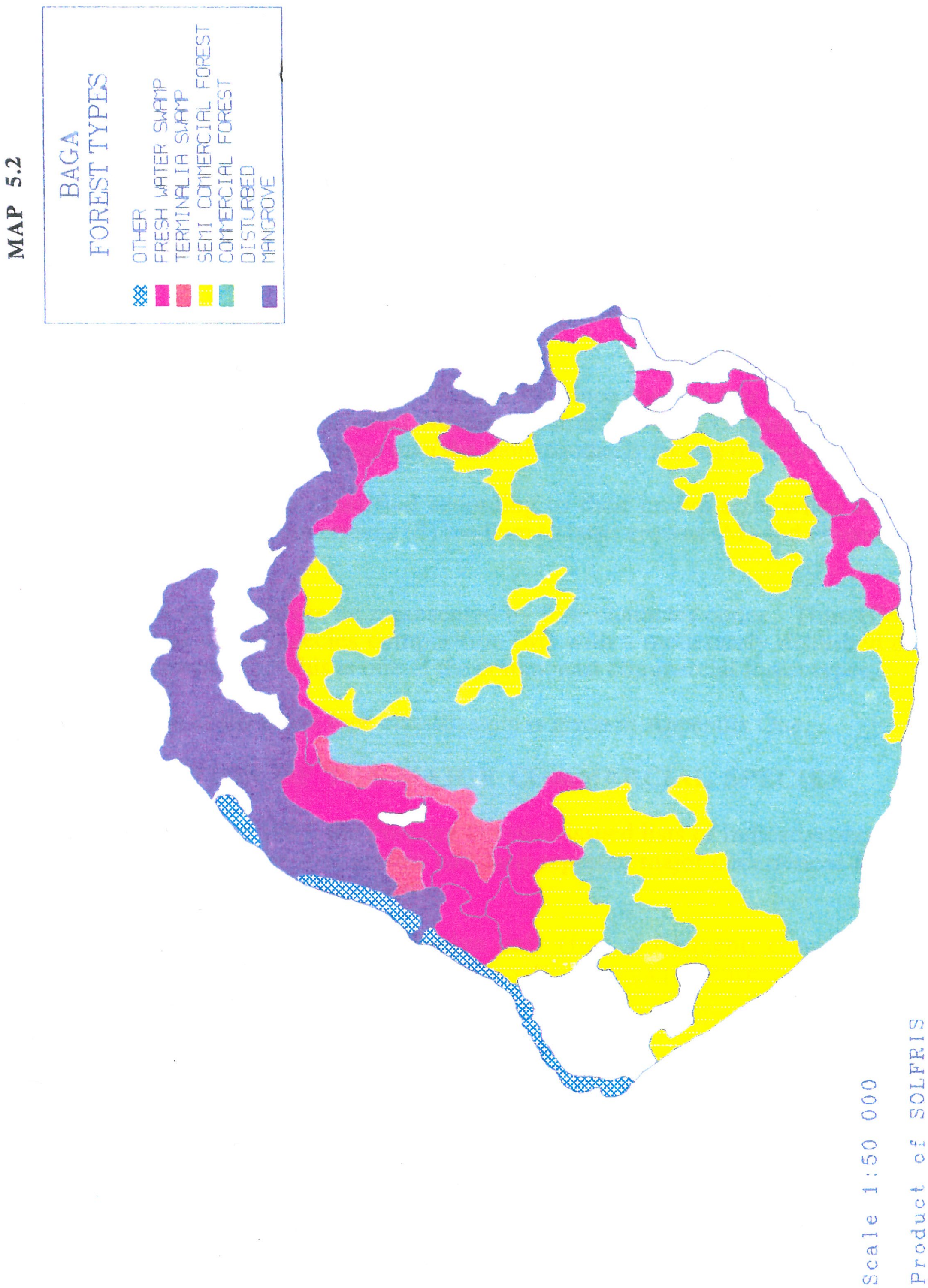
SALINE SWAMP FOREST (S)	
SM	Saline swamp forest, mixed spp composition
SN	Degraded forest
FRESHWATER SWAMP AND RIVERAINE FOREST (F)	
FC	*Casuarina* dominated freshwater swamp/riveraine forest
FH	*Hibiscus tiliacus* dominated swamp forest
FK	*Campnosperma* dominated freshwater swamp/riveraine forest
FL	Logged forest
FM	Freshwater swamp/riveraine forest, mixed spp composition
FN	Degraded forest
FP	Pandan dominated freshwater swamp/riveraine forest
FS	Sago swamp forest
FT	*Terminalia* dominated freshwater swamp/riveraine forest
LOWLAND FORESTS (ON NEARLY LEVEL LANDS) (L)	
LB	Lowland beach forest
LC	*Casuarina* dominated lowland rainforest
LL	Logged lowland rainforest
LK	*Campnosperma* dominated lowland rainforest
LM	Lowland rainforest, mixed spp composition
LN	Degraded lowland rainforest
HILL FORESTS (H)	
HA	*Albizzia falcataria* dominated hills rainforest
HC	*Casuarina papuana* dominated hills rainforest
HK	*Campnosperma* dominated hills rainforest
HL	Logged hills forest
HM	Hills forest, mixed species composition
HN	Degraded lowland rainforest on hills
HR	Maritime atoll hills rainforest
HX	*Agathis* dominated hills rainforest
MONTANE FOREST (M)	
UM	Upland forest on hills, mixed spp composition
NON FOREST AND OTHER AREAS (N)	
NC	Cloud obscured areas
NH	Herbaceous swamps, mixed spp composition
NL	Lakes
NP	Plantations (including forest plantations)
NR	Braided river courses

MAP 5.1
RUSSELL ISLANDS FOREST
TYPE AND SLOPE



Scale 1: 50,000

MAP 5.2
BAGHA FOREST TYPES



5.2 FOREST CONDITION

Canopy disturbance gives the best indication of forest condition and can be derived from aerial photographs which show the severity of the disturbance from either natural events (cyclones, etc) or from man's activities (clearing, logging, etc). To provide an index, three canopy density classes have been recognised.

> **Canopy Density Class One** usually indicates forest that has been most severely degraded by wind, land slip, cultivation or land clearing for other purposes.
>
> **Canopy Density Class Two** typically indicates severe to moderate disturbance, usually by cyclonic events, landslips or high impact logging operations.
>
> **Canopy Density Class Three** indicates moderate disturbance to the forest. Relatively low impact past logging operations may cause this class.

Sometimes it is difficult to differentiate past logging operations from cyclone damage, particularly where former roads and log dumps are no longer obvious on the photographs. This of course depends on road width, intensity of logging and the time that has elapsed to the date of the photography.

In general the forests of Choiseul and Western Province showed less signs of extensive damage from cyclonic disturbances than Isabel, Malaita, Central Province, Guadalcanal and Malaita, which in turn showed less signs of damage than the more southerly forests of Rennell and Temotu.

The forests have also been classified according to their crown size, when three classes were recognised: small to medium crowns (S) medium to large crowns (M) and crowns of various sizes (V).

The forest types can therefore be represented by four character codes. Thus HM3V indicates a hills forest (H) of mixed species composition (M) with a moderately disturbed canopy (3) and various sized crowns (V). This is one of the commonest commercial forest types.

A full explanation of the forest type classification is given in Appendix One.

5.3 DISTRIBUTION OF THE MAJOR COMMERCIAL SPECIES

During the latter part of 1993, the Forestry Division issued lists of indicative export prices in four groups. The species in the four groups and their reported major occurrences from the inventory field data are shown in Table 5.2 below.

The frequency of occurrence is indicative only (freq = frequent, comm = common, occ = occasional); if only a few occurrences were reported from a province, it is shown in brackets eg, (G).

The data was collected by tree namers who may not have been able to identify every tree to the species level, but who have had a lot of experience in identifying timber species.

Provinces are shown by their initial letter; note that Central Province was included with Guadalcanal.

The inventory analysed data collected by the field teams and tentatively proposed several major tree associations for trees over 60 centimetres in diameter (Shenk, 1993). These include:

Pometia pinnata association covering all of Solomon Islands, except Rennell;

Vitex/Pommetia association covering all of Solomon Islands, except Makira, Rennell and Temotu;

Pterocarpus indicus association located in Malaita and Temotu;

Dillenia salomonensis association covering all of Solomon Islands, except Central Province, Guadalcanal, Makira, Rennell and Temotu;

Palaquium spp association which occurs in Malaita, Temotu and Rennell;

Campnosperma brevipetiolata association occurring in the northern parts - Choiseul, Isabel and Western, and in Temotu.

He also identified associations for smaller trees, 30 to 60 cm and below 30 cm in diameter: see Working Paper 15 (Schenk, 1993).

TABLE 5.2
OCCURRENCE OF THE MAJOR TIMBER SPECIES IN THE SOLOMON ISLANDS

Species	Occurrence	Locations by Province
GROUP 1.		
Intsia bijuga (Kwila)	occ	C, G, W, T
Planchonella spp	occ	C, R.
Palaquium spp	comm	C, G, Ml, I, W,Mk,R, (T)
Callophyllum kajewskii	comm	C, G, Ml, I, W, Mk
Callophyllum vitiense	comm	C, G, W, Mk, T
Pometia pinnata	freq	C, G, Ml, I, W, Mk, T
Schizomeria brassii	occ	C, G, Ml, I, W, Mk
GROUP 2		
Canarium spp	comm	C, G, Ml, I, W, Mk, R, T
Burkella obovata	comm	C, G, Ml, I, W, Mk, R, T
Terminalia brassii	comm	C, G, Ml, I, W, Mk
T. calamansanai	occ	C, G, (Ml) I, (W) Mk
T. aff rubiginosa	comm	C, G, Ml, I, W, Mk, R
GROUP 3		
Celtis spp	occ	C, G, Ml, I, W, Mk, R, T
Alstonia scholaris	occ	C, G, Ml, I, W, Mk
Dysoxylum spp	comm	C,(G) (Ml) I, W, Mk, R T
Dillenia spp	comm	C, G, Ml, I, W, Mk
Eugenia spp	comm	C, G, Ml, I, W, Mk, R, T
Endospermum medullosum	comm	C, G, Ml, I, W, Mk, R, T
GROUP 4		
Campnosperma brevipetiolata freq		C, I, W, T
SPECIAL		
Gmelina moluccana	occ	C, G, (Ml), I, W, Mk
Pterocarpus indicus	comm	C, G, Ml, I, W, (Mk) T
Vitex cofassus	comm	C, G, Ml, I, W, Mk
Agathis macrophylla	occ	T

Key:

freq	=	frequent	commm	=	common
occ	=	occasional	C	=	Choiseul
G	=	Guadalcanal	I	=	Isabel
Ml	=	Malaita	Mk	=	Makira
R	=	Rennell	T	=	Temotu
W	=	Western Province			

5.4 DISTURBANCES TO SOLOMON ISLAND FORESTS

Previously it was thought that tropical rain forests were static, and that they had reached a climax or equilibrium. However, current thinking is they are dynamic and constantly in a state of change, responding to various disturbances.

Using data collected by the field teams , Schenk (1993) investigated the influence of aspect, slope, soils and disturbance on the structure of Solomon Island forests. In spite of a detailed computerised cluster analysis, he concluded that there was no relationship between forest structure and aspect, slope and soil (except in some of the more unusual soils, such as those derived from serpentines). However, forest structure was strongly related to disturbance.

In the Solomon Islands these disturbances include:

changes in land use by man (subsistence gardening, clearing for small plantations including agroforestry and villages);

incidental changes by man (walking tracks etc);

small scale harvesting of forest products (such as construction materials, nowadays often using a chainsaw or portable sawmill);

large scale logging;

cyclones and strong winds;

normal processes of aging and decay;

digging by animals (particularly pigs);

fire;

land slips;

flooding.

It should also be noted that the inventory's field work was mainly limited to potentially commercial forests, usually hills rainforests, and that only a little work was done at higher altitudes (where aspect may be more influential).

Of 1,109 plots surveyed for structural features, 69% were disturbed by cyclones or strong winds; 57% contained fallen trees (often associated with cyclones or strong winds); 25% were disturbed by animal digging; 17% by flooding; 13% by walking tracks; 9% by large scale logging; 8% by landslips; 4% by old gardens; 2% by plantations; 1.5% by fire; 1% by animals; 1% by new gardens; and 1% by small scale logging (see Figure 5.2).

Dead standing trees occurred in 28% of the plots and logs in 74%, which gave further evidence of the importance of tree falls.

Gaps and, to a greater extent gap size related to disturbance were found to be important. Canopy gaps were absent in only 1.6% of the plots; 56% had large gaps; 29% had many gaps; and only 13% had small gaps (see Figure 5.3).

The resulting picture is one of disturbed forests with many gaps, high levels of light penetrating the upper and middle canopies (but not necessarily reaching to the ground) with abundant and vigorous seedlings and small saplings (99% of plots had seedlings present).

FIG 5.2 FOREST DISTURBANCE
(% of plots disturbed by each agency)

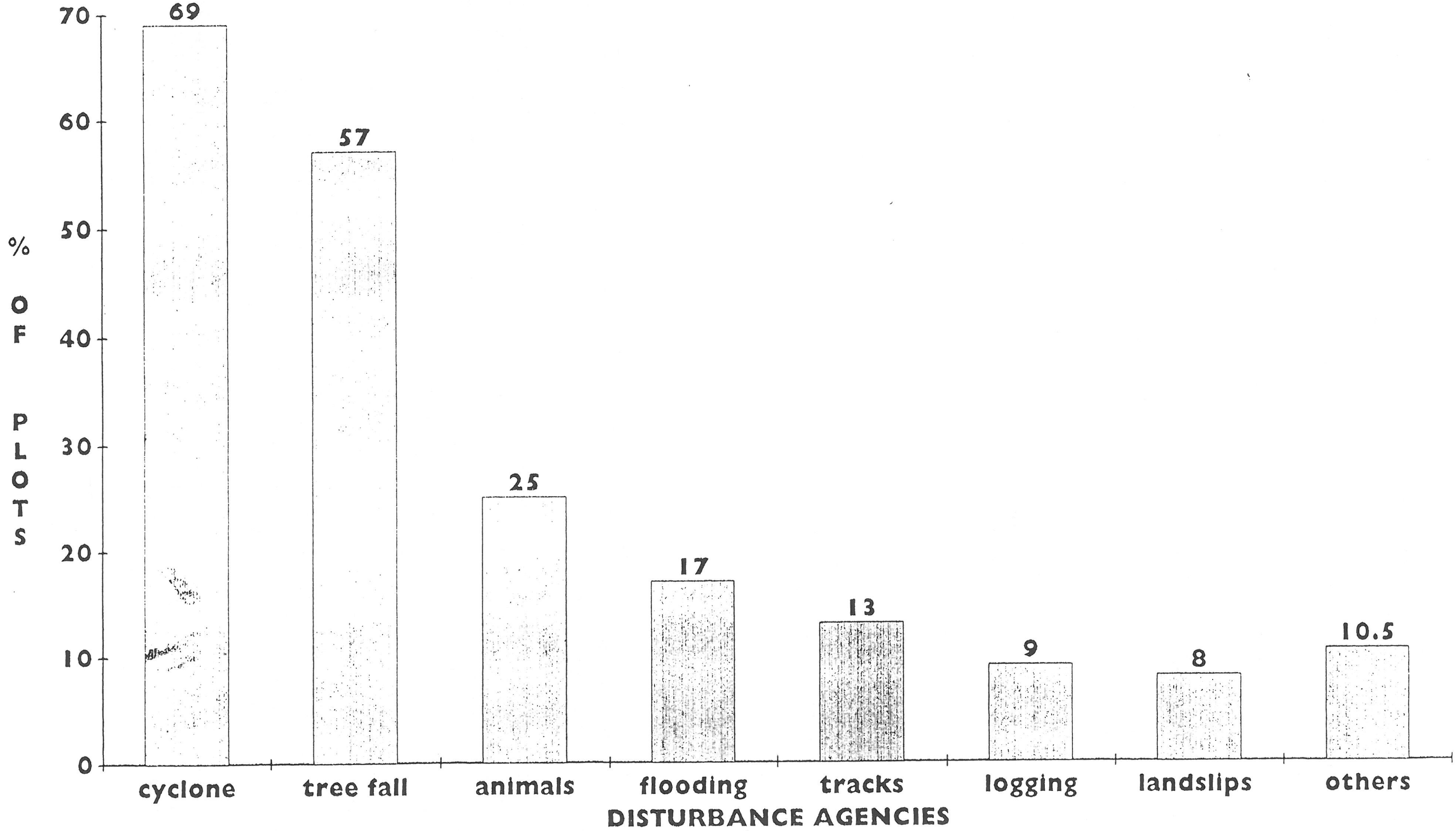
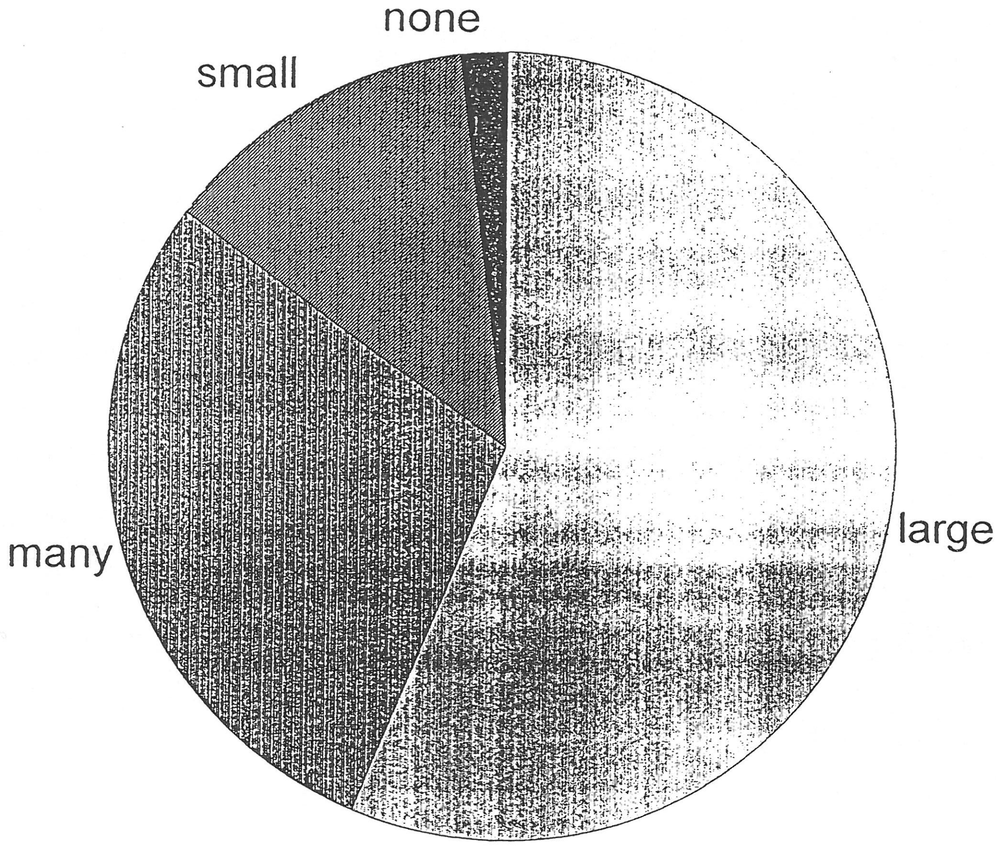


FIGURE 5.3
GAP SIZES



The inventory concluded that over the past 14,000 - 20,000 years, since the last ice age, Solomon Island forests have become adapted to cyclones (and other natural disturbances) and can recover quickly from their effects, either from seeds and seedlings or by the ability of saplings and trees to grow in response to increased light as gaps are formed.

This is particularly relevant to forest management since, if logging can mimic the effects of cyclones, the forests should recover.

(The 1,109 plots referred to above did not include the 201 plots assessed on Rennell which showed an even greater percentage of plots disturbed by cyclones (97%) and more fallen trees (96% of plots). This is as would be expected after cyclone Nina of early 1993. However there was no sign of disturbance by pigs and only 5% of these plots showed signs of flooding.)

5.5 THE ROLE OF CYCLONES

The most dramatic natural disturbances to the Solomon Island forests are those that occur during cyclonic events, eg. the destructively heavy rains and winds.

Many cyclones begin as tropical depressions to the north and east of the Solomons. (The map of cyclone tracks prepared by the Solomon Islands Meteorological Service shows 18 cyclones which developed in this area, and another nine which developed to the south and west, since 1955.) They usually deepen as they move away from Solomon Islands waters so they are more destructive elsewhere. On the other hand cyclones occasionally come to the Solomon Islands from distant parts. These have had time to intensify and are therefore destructive, eg. Nina (1993) which originated in the Gulf of Carpentaria and eventually affected Rennell and Bellona and Nendo Islands.

Recent cyclones which are known to have damaged forests include:

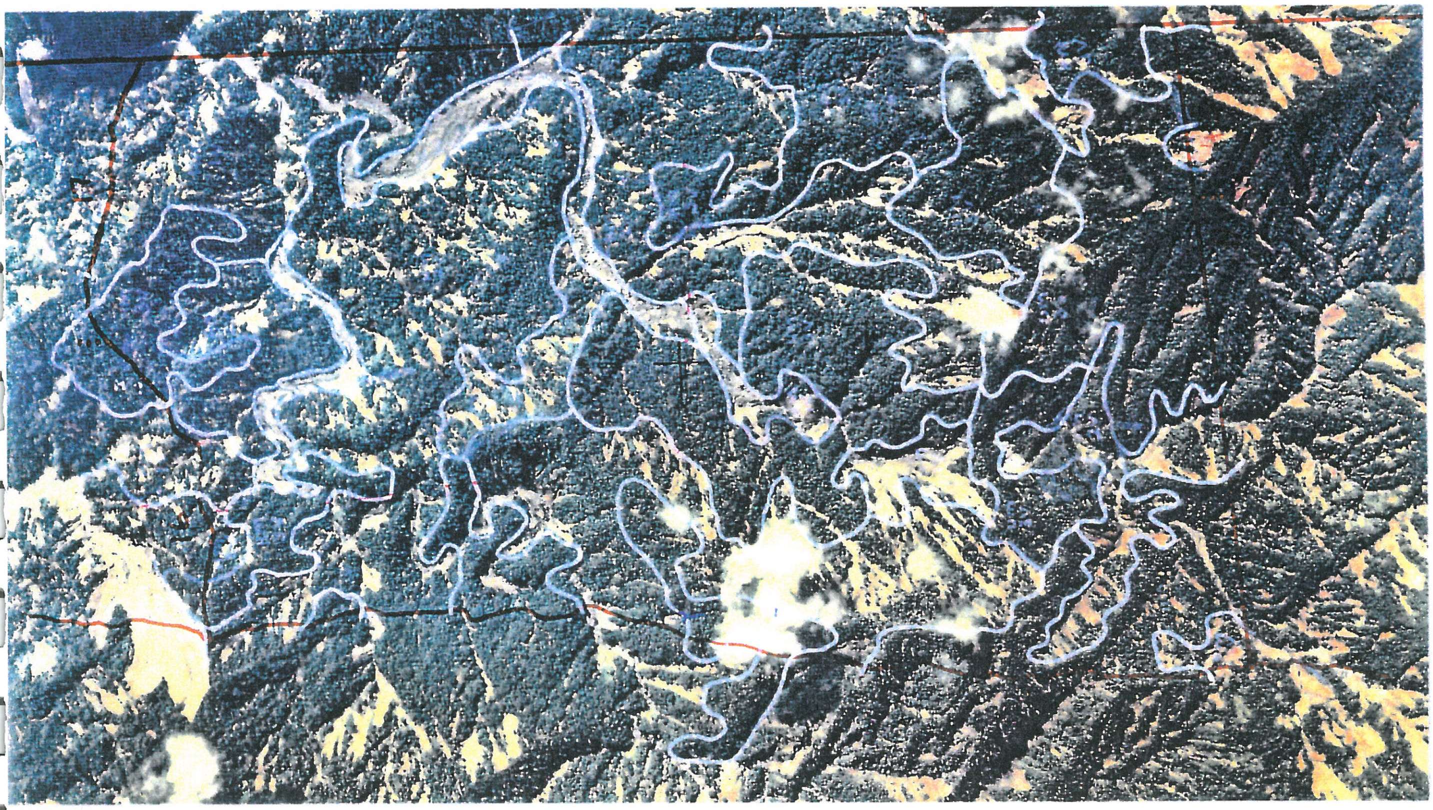
- **ANNIE - 1967,** which damaged forests on Kolombangara, including the plots forming part of the Kolombangara Ecological Study;
- **IDA - 1972,** which originated off Choiseul and then travelled along the NW-SE axis of Isabel and therefore damaged forests extensively, including the Allardyce forests and associated logging operation;
- **EMILY - 1972** (Makira);
- **KERRY - 1979** (Ulawa and Makira);
- **NAMU - 1986** (Malaita, Guadalcanal and Makira);
- **NINA - 1993,** which passed over Rennell with more force than is usual in Solomon Islands and then affected Nendo and Utupua Islands in Temotu Province.

Notes on the effects of cyclones on the Solomons forests are included in Appendix Three.

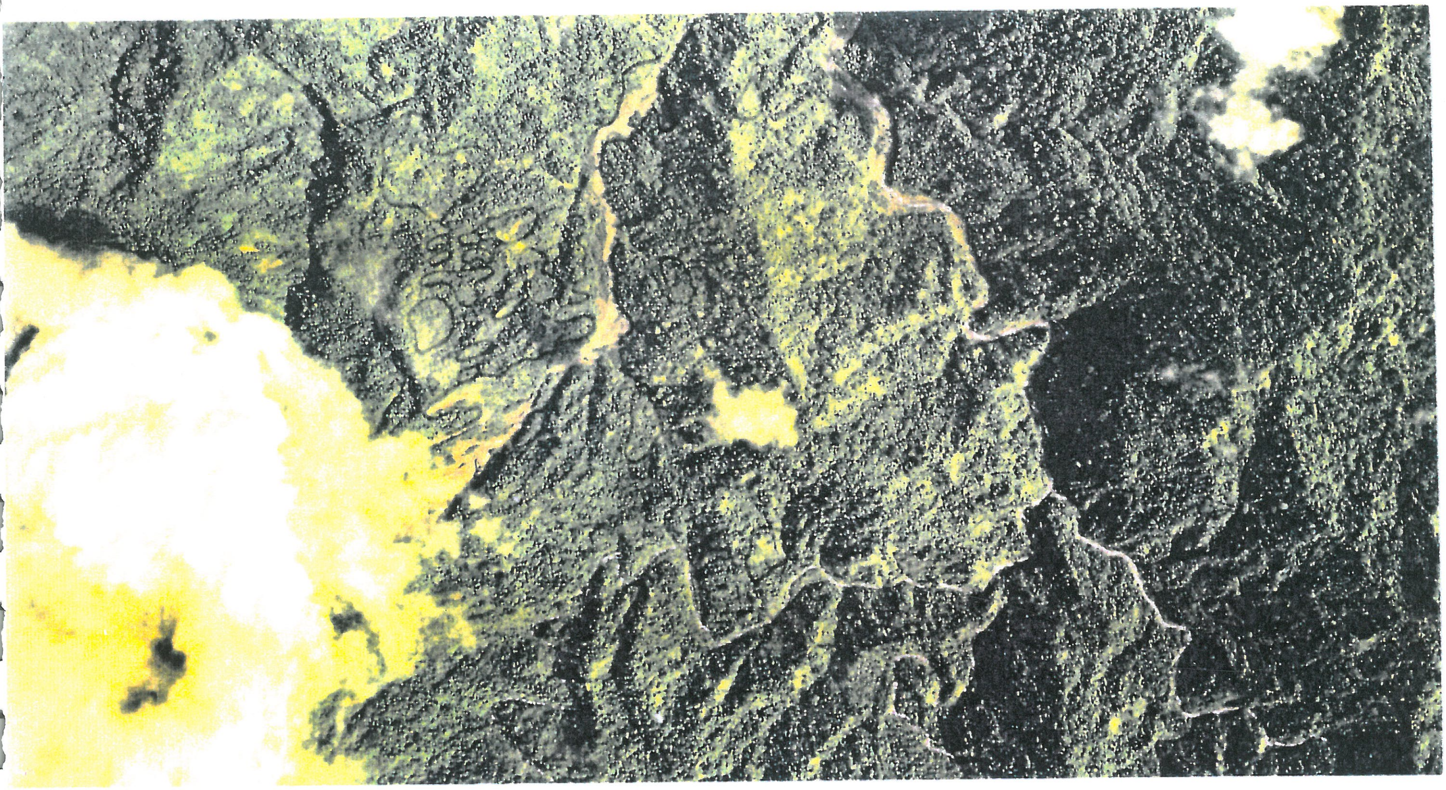
Some of the damage caused by Cyclone Namu (1986) to upland parts of eastern Guadalcanal is shown in Figure 5.4. By 1992, revegetation had occurred, confirming the ability of Solomon Island forests to recover.

A fuller description of the role and effects of cyclones is given in Appendix Three.

FIGURE 5.4
AERIAL PHOTOGRAPHS OF PARTS OF GUALDALCANAL SHOWING AREAS DAMAGED BY CYCLONE NAMU IN 1986.



AERIAL PHOTOGRAPHS OF PARTS OF GUALDALCANAL SHOWING AREAS DAMAGED BY CYCLONE NAMU IN 1991.



COMMERCIAL FORESTRY ASPECTS

6. COMMERCIAL FORESTRY ASPECTS

6.1 DEFINITIONS AND METHODS

The following definition of commercial forests was adopted: "those forests generally below 400 metres, on a ruling slope of less than 30 degrees and estimated to carry not less than 20 cubic metres per hectare of timber that can be utilised (harvested) now or in the near future, using practices current in Solomon Islands". It was assumed that forests with less than 30 to 40% crown cover would not contain the 20 cu m per ha of commercial timber needed for viable commercial logging. To some extent, however, commercial viability depends on circumstances, particularly the condition of the adjacent forests, accessibility, market prices and species.

The 30 degree ruling slopes were inferred from contour lines on 1:50,000 topographic maps, which can be only approximate since the maps were drawn from aerial photographs taken above dense forest canopies. For the same reason, local relief or rocky areas cannot be taken into account at this level of forest inventory. In practice, however, the topographic limits to which companies actually log are decided on a case by case basis by the logging supervisor or even by the bulldozer driver, so that even if accessible areas could be precisely determined, the results would be subject to interpretation.

6.2 COMPOSITION OF THE COMMERCIAL FORESTS

Table 6.1 gives the trees per hectare of trees in three different size classes: 10-30 cm (indicating the abundance of young saplings) 30-60 cm (indicating the abundance of trees that would mature to form another commercial crop) and >60cm (trees that are now mature). Figures for both logged and unlogged forests are given. From Table 6.2 which gives the numbers of trees in logged stands it can be seen that there is potential for recovery after logging provided that the operations do not let in too much light or cause too much compaction.

This is supported by recovery from logging at Temotu (on Vanikoro Island) which was sufficiently benign for forests to recover. Logging at Bagha Island in the Western Province also allowed the forests to recover, in contrast with a heavily logged forest near Ringgi, Kolombangara where there was evidence that the forest, even after 30 years, had not yet formed another commercial crop (Olsen and Turnbull, 1993).

The smallest size class (10 - 29 cm) was not estimated in the earlier stages of the inventory (Guadalcanal and Malaita). However, data collected by the environmental teams confirmed that this class was abundant in these two Provinces. In most situations in the Solomon Islands, the forests have enough seedlings, small saplings, and medium sized trees to form new crops after logging or after disturbances by cyclones.

However, logging can damage the forests by opening gaps that are too large, and by compacting more of the soils than is necessary so that recovery after logging is too slow for another crop to grow in a reasonable time frame.

TABLE 6.1
TREES PER HECTARE OF THE MAJOR TIMBER SPECIES
(FORESTS THAT HAVE NOT BEEN LOGGED)

PROVINCE	DIAMETER CLASSES		
	10-29 cm	30-59 cm	>60 cm
Guadalcanal	n/a	50	12.85
Malaita	n/a	58	15.0
Choiseul	363	67	14.35
Isabel	348	59	12.0
Western Province	403.5	70	17.1
Makira	408	39	12.6
Temotu:			
Nendo	392	38	11.1
Vanikoro	604	58	17.1
Rennell	249*	66#	27+

Key: * 10-19 cm; # 20-39 cm; + >40 cm; n/a = not assessed

From Table 6.1, the inventory concluded that usually there are ample numbers of small seedlings and small trees to form another crop, **provided that** logging is done in a way that mimics cyclone and wind damage.

TABLE 6.2
TREES PER HECTARE OF THE MAJOR TIMBER SPECIES
(FORESTS THAT HAVE BEEN LOGGED)

PROVINCE	DIAMETER CLASSES		
	10-29 cm	30-59 cm	>60 cm
Guadalcanal	n/a	34	8.45
Western Province	391	43	6.3
Makira	348	28	5.2
Temotu (Vanikoro)	671	91	15.5

Key: n/a = not assessed

Gross volumes per hectare by different size classes on unlogged and logged forests for each province are set out in Table 6.3 and 6.4. Merchantable volumes per unlogged forest are set out in Table 6.5. (See Appendix Four for details of how merchantable volumes are derived). In all cases the 60+ class includes all trees of 60 cm diameter and over, the 70+ cm class includes all trees over 70 cm, etc.

TABLE 6.3
GROSS VOLUMES PER HECTARE OF THE MAJOR TIMBER SPECIES (FORESTS THAT HAVE NOT BEEN LOGGED)

PROVINCE	DIAMETER CLASSES (diameter at breast height or above buttress)				
	60^+ cm	70^+ cm	80^+ cm	90^+ cm	100^+
Guadalcanal	45.5	29.1	16.2	8.4	5.1
Malaita	50.3	37.1	23.4	14.2	9.6
Choiseul	80.1	57.7	38.3	24.1	12.3
Isabel	52.7	40.6	28.0	18.5	11.9
Western Province	83.1	69.3	52.2	36.3	25.2
Makira	44.0	31.8	17.3	9.6	4.7
Temotu:					
Nendo	37.5	26.4	14.2	6.4	3.3
Vanikoro	73.1	59.8	43.3	36.8	27.5
all areas	42.75	32.7	21.4	15.7	11.1
Rennell	22.5	9.0	2.5	0.9	0.3

TABLE 6.4
GROSS VOLUMES PER HECTARE OF THE MAJOR TIMBER SPECIES (FORESTS THAT HAVE BEEN LOGGED)

PROVINCE	DIAMETER CLASSES (diameter at breast height or above buttress)				
	60+ cm	70+ cm	80+ cm	90+ cm	100+
Guadalcanal	33.0	20.6	12.6	5.6	4.4
Western Province	22.5	13.5	8.5	4.9	2.4
Makira	17.3	11.3	4.4	3.55	2.1
Temotu (Vanikoro)	64.2	48.4	33.4	25.9	20.2

TABLE 6.5
MERCHANTABLE VOLUMES PER HECTARE (FORESTS THAT HAVE NOT BEEN LOGGED)

PROVINCE	DIAMETER CLASSES (diameter at breast height or above buttress)				
	60+ cm	70+ cm	80+ cm	90+ cm	100+ cm
Guadalcanal	36.8	23.4	13.1	6.7	4.0
Central Province	55.9	37.0	22.5	12.8	8.9
Malaita	46.6	35.0	22.7	14.1	9.4
Choiseul	56.8	41.2	27.4	17.0	8.5
Isabel	37.0	28.6	19.7	13.1	8.2
Western Province	66.5	56.0	42.6	29.8	20.8
Makira	34.7	25.3	13.6	7.5	3.8
Temotu	44.2	34.4	23.2	17.4	12.3
Rennell	18.6	7.7	2.4	1.1	0.4

Pometia pinnata (taun) contributes most of the gross commercial volume (60 cm diameter and above) in the unlogged forests of Guadalcanal (32%) Malaita (40%) Choiseul (29%) Isabel (31%) and Makira (37%). However, in Western Province it contributes only about 10% of the gross volume, with *Dillenia* spp (21%) *Campnosperma brevipetiolata* (18%) and *Callophyllum* spp (17%) contributing more.

In Nendo *Pometia pinnata* contributes only 5% of the gross volume, while *Campnosperma brevipetiolata* contributes 40%. In Vanikoro, *Pometia pinnata* occurs infrequently, and *Agathis macrophylla* (39%) and *Campnosperma brevipetiolata* (37%) together contribute most of the gross volume.

Pometia pinnata was not found in Rennell where the species contributing most of the gross volume were *Palaquium* spp (28%) and *Endospermum medullosum* (20%).

These figures suggest that if post logging treatment of forests attempted to ensure that regeneration of *Pometia pinnata*, (which produces a good general utility timber) is able to grow into a new timber crop, such treatment would be successful.

Other species which were quite widespread in their distribution include *Vitex cofassus* (except in Western Province) and *Callophyllum kajewskii* and *C. vitiense* (except in Makira). *Dillenia* spp were important in Western Province and *Campnosperma brevipetiolata* is important in Western Province, Temotu, and Choiseul, and to some extent in Isabel but not in Guadalcanal and Makira.

TABLE 6.6
AREAS OF MERCHANTABLE FOREST IN EACH PROVINCE
(areas are in hectares)

Province	Gross Area	Loggable Area*	Reduced Area **
Guadalcanal	95,296	71,837	18,445
Central	25,176	14,398	# 8,460
Choiseul	193,428	115,254	***62,472
Malaita	111,390	54,029	***18,602
Isabel	175,586	71,630	46,923
Western Province	250,472	182,178	***82,650
Makira	71,922	31,910	13,360
Temotu	36,068	23,360	9,000
Rennell	44,072	33,904	18,309
Total	**1,003,410**	**598,500**	**278,221**

* This is the area reduced as described in Appendix Four, and represents the area that ought to be loggable using conventional methods in use in the Solomon Islands as at 1993.

** The reduced area is the area remaining after deducting all land that should not be logged in order to protect the environment, to conserve ecologically significant areas or to retain an area of one km diameter around each village. These reduced areas were used to make preliminary estimates of allowable annual cuts.

*** Logged areas (as at late 1993) have been deducted in the cases of Western Province, Choiseul and Malaita, but not in the cases of Guadalcanal, Temotu and Isabel. In the latter three provinces, areas that had been logged earlier had recovered to form another crop. However in view of the grave doubts that have been expressed on the ability of forests to recover from current logging methods ("Solomons style") areas that have already been logged have not been included in these calculations.

\# Estimated from national figures.

TABLE 6.7
VOLUMES OF MERCHANTABLE TIMBER
(UNLOGGED FORESTS)

Province	Loggable Volume cu m	"Safe" Volume* cu m
Choiseul	6,546,400	3,660,100
Western Province	12,114,800	5,500,000
Isabel	2,650,310	1,736,000
Malaita	2,517,750	866,760
Guadalcanal	2,643,600	678,800
Makira	1,130,000	463,000
Temotu	1,032,500	396,000
Rennell	630,600	340,550
Central	702,700	328,500

These volumes are ± the error percentages in Table 6.8. They are underbark volumes for trees of 60 cm diameter and over, except in the case of Rennell where the volumes are for trees greater than 40 cm diameter. As mentioned in Chapter One, the inventory was developed to provide the errors of estimate of ± 10% at the 95% confidence level (i.e. if the inventory were to be repeated, the results for each region would be within 10% in 19 cases out of 20). A lower standard of precision would be acceptable in the less important regions (Temotu and Rennell, and logged areas).

TABLE 6.8
PRECISION OF VOLUME ESTIMATES
(Calculated volumes will be ± the percentage given, with 95% confidence.)

Province/group	Gross volume		Merch Volume
	not logged	logged	
Choiseul/W. Province [1]	4.9	n/a	n/a
GC-Malaita-Makira-Isabel[1]	5.4	n/a	n/a
Choiseul	8.75	n/a	8.1
Western Province	6.7	n/a	6.9
Isabel	9.9	n/a	10.8
Malaita	11.2	n/a	10.9
Guadalcanal	11.0	18.8*	11.7
Makira	10.2	35.6*	10.4
Temotu	10.5	28.6*	12.4
Rennell	2.0	n/a	2.0

1 The gross volumes per hectare were calculated for two groups of provinces: Western Province and Choiseul combined, and Guadalcanal. Malaita, Makira and Isabel combined, these being groupings of regions with similar gross volumes per hectare (within the error of estimate).

* The relatively large errors for logged plots in Guadalcanal, Makira and Temotu is due to the small number of plots in those forest areas.

The percentages of logs that would fall into form class I (export quality) and form class II (sawmill quality)are given in table 6.9

TABLE 6.9
PERCENTAGES OF LOGS WHICH ARE IN FORM CLASSES I AND II

REGION	CLASS I	CLASS II
Choiseul	83	17
Western Province	85	15
Isabel	n/a	n/a.
Malaita	78	22
Guadalcanal	74	26
Makira	73	27
Central Province	85	15
Rennell	85	15
Temotu	72	18

OTHER FINDINGS OF THE INVENTORY

7. OTHER FINDINGS OF THE INVENTORY

A national forest inventory gives a good foundation for forest management. With this in mind, several other activities were carried out by the inventory, to give an even broader base. These have not been reported in the major chapters of this volume, so brief summaries of these activities and their major findings are given here. The findings have been fully reported in the various working papers produced by the inventory: a list of which is given in Appendix One.

The activities are:

- preparation of volume tables;
- identification of plantation opportunity areas;
- sustainable harvesting of indigenous forests;
- the recovery of forests after logging;
- planning study;
- policy and legislative aspects

7.1 VOLUME TABLES

While the field teams were collecting data from plots, a separate team collected data from felled trees in logging concessions. This team measured log length and diameter at regular intervals of about 100 felled trees in each concession (in a few cases, measurements of standing trees were taken with a relascope).

It was found that there were no significant differences between species in the different provinces, and that it was just as efficient to combine many of the species into one table.

At the suggestion of AIDAB in the Mid Term Review, an attempt was made to make a one way volume table (giving volume from diameter only) but this was found to be too inaccurate for use, giving a result which was $\pm$ 29%, so the tables are based on two-way functions (diameter and length) which gave an error of $\pm$ 11%.

Working paper 16 (Volume Tables for Indigenous Trees of the Solomon Islands by R. B. Tennent) contains six tables, giving under bark volumes from underbark measurements of diameter and length for groups of trees having thin, medium and thick bark. Two further tables give additional information on bark thicknesses.

The two-way equation which gave the best results was:

$$V = e^{(-8.912 + (1.944 \log D) + (0.77 \log L)}.$$

Where V = volume, e = the natural function, D = diameter and L = length of log

7.2 PLANTATION OPPORTUNITY AREAS

An analysis of plantation opportunities for the Solomon Islands concluded that the Solomon Islands has a comparative advantage in producing wood chips for Japan since ocean freight times are much less than for other regions. This led to the conclusion that plantations should be large in extent and based on land that had excellent growth potential. The tropical acacias would be suitable species for pulp chips because they have a high basic density, they are also suitable for sawn timber and veneer.

A method was derived to identify suitable "Plantation Opportunity Areas" based on the agricultural opportunity areas of Hansell and Wall (1974-6).

The best prospects for POAs were found to be in Western Province, particularly at Enoghae but there were other possible areas in Guadalcanal and Malaita. (If trees were to be grown for end products with a higher value than pulpwood chips, smaller areas would be acceptable.)

It was pointed out that further feasibility studies should follow this investigation.

The results of this activity are presented in Working Paper 13 (Plantation Opportunity Areas in the Solomon Islands by E. D. Shield.)

7.3 SUSTAINABLE HARVESTING OF INDIGENOUS FORESTS

Originally it was proposed that the inventory gather information on conditions to be included in logging agreements, such as codes of logging practice, but it was found that the Timber Control Unit of the Forestry Department would do this. It was then agreed that the inventory would indicate processes by which logging could be conducted in a way that allowed for multiple uses of the forest to continue in a sustainable way. The difficulties of implementing the processes in the Solomon Islands were recognised. The Forestry Division has insufficient resources to intervene in logging to the extent necessary, nor to prepare sustainable resource plans. Current logging company operations are characterised by management that is insensitive to environmental conservation and by a general absence of planning.

The working paper considers the environmental impacts of present logging operations and proposes ways of developing more sustainable operations, including a zoning of forests according to soil susceptibility, environmental sensitivities and ecological significance (this is developed in each of the regional reports) and appropriate plans which have to be supported by different levels of forest inventory.

The principles put forward by this activity are considered to be vitally important for sustained use of natural resources in the Solomon Islands (including marine resources) and have been reported in Working Paper 14 (Policies and Practices for the Management of Indigenous Forests in the Solomon Islands by E. D. Shield).

7.4 THE RECOVERY OF FORESTS AFTER LOGGING

The extent to which forests recover after logging is the most important factor affecting the long term viability of forest based development in the Solomon Islands.

If long term yield predictions are made on the assumption that forests will recover from logging and they do not, then any such predictions are absolutely meaningless.

There is conflicting evidence on the recovery of forests after logging - several examples exist in the Solomons of forests that have been logged and now carry a crop with sufficient volume to be logged again: forests at Vanikoro that were logged by the Vanikoro Logging Company (particularly the approximately 1,000 or so hectares that were treated to get better regeneration); areas on Bagha Island that were logged by a Japanese Company in the early 1960s, areas on Guadalcanal that were logged for the Foxwood Mill and areas that were logged for a "Forestmill" operation by Mr Schenk.

The Solomons forests also recover from cyclones.

However, the current logging operations generally remove more trees with bigger machines operated by relatively unskilled and untrained drivers. So it is widely held that forests will now recover only in a very long time. Thus Olsen and Turnbull (1993) reported that an area on Kolombangara logged in the early 1960s in the same way that forests are being logged at present showed no signs of recovery to the state that it could be logged again in the near future.

To test this finding, a series of permanent sample plots were established in 1993, in Western Province, at Kolombangara, Viru and Vangunu. More plots need to be established to get reliable results.

As a precursor to this work, a detailed literature review was made and reported in Working Paper 17, and the work leading to the setting up of the permanent sample plots was reported in Working Paper 18.

7.5 A LOCAL LEVEL PLANNING STUDY

Clearly if forests are to be logged sustainably in the Solomon Islands, management by the resource owners, the villagers themselves must be effective (whether the forests are to be logged by commercial operations, or by small scale portable mills). Ways of planning the harvesting of forests by local people need to be worked out.

The inventory carried out a study at Bagha Island and proposed ways of planning and managing forests by local people. This work is reported in Working Paper 20 (by W. D. Incoll).

7.6 OVERVIEW OF THE SOLOMON ISLANDS FORESTRY SECTOR

During the pilot phase of the inventory project, a study, from an economic point of view was made of the Solomon Islands forestry sector.

This considered policy, legislation, economics and utilisation aspects and gave a useful account of the sector and identified some of actions needed if the forests are to be managed on a sustained yield basis and for logging operations to be controlled. The study is reported in Working Paper 2 (by E. D. Shield).

MAJOR IMPLICATIONS FOR FOREST-BASED DEVELOPMENT

8. MAJOR IMPLICATIONS FOR FOREST-BASED DEVELOPMENT

At the moment, the Solomon Islands relies heavily on income from export logging to earn foreign exchange: without this income the economy would be in dire straits and development of social services (health and education) would not proceed. To add to this, the forests are already under pressure from a population that is increasing at a very high rate of 3.6 % per year (i.e. doubling every 20 years) for land for subsistence gardens and materials traditionally used for houses, tools, canoes, medicines, crafts and plants and animals used for food.

In 1992, the national income from timber and log exports was $ SI 110,452,000 of which only $ SI 6,434,000 came from sawn timber. (Central Bank of the Solomon Islands, Annual Report.)

On the international scene, many countries are curtailing the export of logs, so that the demand for the Solomons resource is strong.

8.1 SOCIAL ASPECTS

The inventory found that some materials traditionally obtained from forest were becoming much harder to find. Also, land for subsistence gardening is being left fallow for shorter periods than in earlier times. This is worrying and requires national interventions to introduce improved farming systems which should include tree crops and agro-forestry.

The benefits usually expected from commercial logging were generally received by local people, such as money from royalties, employment, roads, and access to company assets such as stores and health posts. The disbenefits were however, found to be considerable and most people regretted having their forests logged: problems were associated with spoilt stream, damaged soils, less material for building, less wildlife, damage to gardens and to tambu sites.

Quite a large percentage (61%) of the villages surveyed had chainsaws, often used for clearing garden sits but 11% of villages had access to portable sawmills.

Villagers had a good knowledge of the effects of deforestation. The next step, of informing villages how to manage their forests has not been undertaken and the inventory started to do this as part of its efforts to tell Solomon Islands people about the results of the inventory. There is a need for some bureau or agency to advise village people on how to draw up plans for ecologically sustainable harvesting of their natural resources.

8.2 ENVIRONMENTAL ASPECTS

The most valuable role of the Solomon Islands forests is to protect the soils which are often highly erodible from the very heavy (erosive) rain. The inventory classified lands into five categories of susceptibility to damage from logging or land clearing. This showed the lands which would be most at risk, but revision of the classification in the light of experience gained in its application is probably warranted.

The inventory identified the major ecological domains (areas of land with similar physical characteristics), described the structure and floristics of the forests; identified major centres of biodiversity and of particular biological significance; proposed areas which should be protected for environmental reason; and identified areas where there should be some form of environmental conservation.

The need to conserve habitats for Solomon Islands fauna and flora (some of which is endangered or rare and much of which occurs nowhere else in the world) for the benefit of future generations has to be recognised by all those concerned with development of the Solomon Islands, and the identification of these sites is therefore a valuable contribution.

Studies into the disturbances that affect the forests showed that the most widespread are associated with strong winds (especially cyclones) but animal digging (pigs) was also quite widespread. This has a fundamental importance for forest management - if harvesting mimics the effects of cyclones, they should recover. To confirm this, the forests do have many gaps, with high levels of light reaching the middle and lower canopies, (but not usually to the ground) and there are many seedlings and small saplings which are ready to develop if the canopies above them are disturbed.

However it must be noted that there is considerable evidence that if the forests are opened too much, the result will be a plethora of vines and secondary species of no commercial value.

The greatest risk to logging and to plantations is from cyclones as evidenced by cyclone Ida which did great damage to the forests of Isabel as it passed *along* the island, and cyclone Nina which in 1993 damaged plantations at Nendo and passed along the island of Rennell.

8.3 COMMERCIAL ASPECTS

Principally as a result of disturbance, commercial forests of the Solomons can be placed in two major categories: the more highly stocked forests of Choiseul, Western Province and Russell Island which carry a gross volume of about 80 cu m per hectare, and the more disturbed hills forest of Isabel, Malaita, Guadalcanal and Makira which carry a forest with a gross volume of 44 to 50 cu m per hectare.

The forests of Rennell seem to have a low volume because they have been subject to two very severe cyclones, one about 100 years ago, and one in 1993. In Temotu, the forests with Santa Cruz Kauri have high standing volumes (even where previously logged in earlier days) whereas the other forests have an even lower stocking of 36 cu m per ha.

It was found that generally there is a good supply of smaller trees and of seedlings to form subsequent crops - this is seen to be a response to disturbance.

The inventory also estimated the merchantable volume of forests in order to get a better estimate of what would actually be available. This allowed a calculation of the standing volumes in each Province. This area has to be further reduced if great damage to environmentally sensitive and ecologically significant areas is to be avoided, if villagers are to be able to use the forests in traditional ways, and if areas are to be managed for nature conservation. This reduction is considerable and reflects the sensitive nature of the Solomon Islands forest environments as well as their unique non-timber values. Of necessity there are subjective elements, nevertheless the approach was as objective as possible in the circumstances.

The inventory calculated an *indicative allowable cut* for each province. This is the amount that can be cut each year and still sustain yields, provided that logging is done in a way that imitates the effect of cyclones. For this, the gross volumes that have been reduced to loggable volumes as in Appendix Four were further reduced to give a "reduced area" by removing areas that should not be logged for environmental or social reasons. This latter reduction was done by using overlay analyses (in effect maps laid on top of one another in the computer and subtracting the various kinds of land). These areas were then multiplied by the merchantable volumes for each province and divided by 45, on the assumption that the cutting cycle for Solomons forests should be 45 years.

If the volumes being removed from the forests are greatly in excess of these *indicative allowable cuts*, then the logging is most unlikely to be sustainable for a forest-based industry, and undesirable ecological, environmental and social consequences can be expected. In the late 1980s, the annual cut from Solomon Islands forests was generally between 300,000 and 400,000 cubic metres per year. By 1993, the total that was being removed was said to be over one million cubic metres. Since the total indicative allowable cut for Solomon Islands is estimated at 325,000 cu m annually, comprising 292,550 cu m per year from unlogged areas plus an estimated 32,500 cu m from logged over lands, it can be concluded that the annual cut is much too heavy.

However it is stressed that the main task of the inventory was to estimate the size of the forest resource. It is recommended that the methods used to calculate allowable cuts should be reviewed and the figure re-calculated with different assumptions if these are considered more appropriate.

One fundamental factor which will affect the long term nature of the forest based industry greatly, is the extent to which forests will recover from the present "Solomons style" logging. If operations are opening the canopy too much and logging damage to remaining trees and soils is excessive, then future yields will be small.

Now that reliable estimates of timber volumes are available, determining the future management and use of the forests requires a well designed and well executed study of the recovery of forests from logging as currently carried out in the Solomon Islands.

REFERENCES

9. REFERENCES

ALDRICK, J.M., The Susceptibility of Lands to Deterioration in the Solomon Islands National Forest Resources Inventory Project, Project Working Paper 12. Ministry of Natural Resources, Honiara, 1993.

ANPWS, A Representative Protected Forests System for the Solomon Islands, The Maruia Society (for the Australian National Parks and Wildlife Service) Nelson, N.Z., 1991.

FALVEY, D.A., COLWELL, F.B., COLEMAN, P.J., GREENE, H.G., VEDDER, J.G. AND BRUNS, T.R. Petroleum Prospectivity of Pacific Island Arcs: Solomon Islands and Vanuatu. The Apea Journal, 1991.

FLANNERY, T.F., The Mammal Fauna of the Solomon Islands: Its Conservation Status and Relevance to the National Forest Resources Inventory, Solomon Islands National Forest Resources Inventory Project, Project Working Paper 8. Ministry of Natural Resources, Honiara, 1990.

HAMMERMASTER, E.T., Field Inventory Manual, National Forest Resources Inventory Project, Field manual No One, Ministry of Natural Resources. Honiara, 1992.

HANSELL, J.R.F. and WALL, J.R.D., Land Resources of the Solomon Islands, Volumes 1-8 Land Resources Study 18, Min. Overseas Development, U.K., 1974-76.

INCOLL, W.D., Principles and Guidelines for Forest Resource Planning in the Solomon Islands, National Forest Resources Inventory Project, Working Paper 20. Ministry of Natural Resources, Honiara, 1993.

MARTEN, K.D., Tropical Forestry in Melanesia and some Pacific Islands. In: [Eds A.L. Dahl and J. Carew-Reid] Environment and Resources in the South Pacific. UNEP Regional Seas Reports and Studies, no 69. UNEP, 1985.

OLSEN, M.F. and TURNBULL, M.H., Assessment of Growth Rates of Logged and Unlogged Forests in the Solomon Islands. National Forest Resources Inventory Project. Working Paper 18. Ministry of Natural Resources, Honiara, 1993.

SCHENK, J.R., Forest Ecology and Biogeography in the Solomon Islands. National Forest Resources Inventory Project. Working Paper 15 Ministry of Natural Resources, Honiara, 1993.

SHIELD, E.D., Policy, Legislative Framework, Economic and Utilisation Aspects. National Forest Resources Inventory Project, Working Paper 2 Ministry of Natural Resources. Honiara, 1991

SHIELD, E.D., Plantation Opportunity Areas in the Solomon Islands, National Forest Resources Inventory Project, Working Paper 13. Ministry of Natural Resources. Honiara, 1992a.

SHIELD, E.D., Policies and Practices for the Management of Indigenous Forests in the Solomon Islands, National Forest Resources Inventory Project, Working Paper 14. Ministry of Natural Resources, Honiara, 1992b.

SOLOMON ISLANDS GOVERNMENT, Socio-economic Survey of Smallholder Farming Systems in the Solomon Islands, reports of various localities, Honiara 1989.

WHITMORE, T.C. Change with Time and the Role of Cyclones in Tropical Rainforest on Kolombangara, Solomon Islands, Commonwealth Forestry Institute, Paper 46. University of Oxford, 1974.

APPENDIX ONE

LIST OF REPORTS, WORKING PAPERS & MANUALS PREPARED BY THE INVENTORY

SOLOMON ISLANDS NATIONAL FOREST RESOURCES INVENTORY:

PROJECT WORKING PAPERS

No	AUTHOR	TITLE
1	R.J. Cogger	Training and Institutional Needs
2	E.D. Shield	Policy, Legislative Framework, Economic & Utilisation Aspects
3	J.K Hibberd	Ecological Resources and Environmental Implications
4	E.T. Hammermaster	Inventory Design & Techniques
5	R.J. Wilson	Air Photography and Satellite Imagery Interpretation
6	W. Thompson W. Mayr & R. Fenwick	FRIS Design and Application
7	G.P. Fitzgerald P. Schoeffel	Sociological Survey of Villages in the Pilot Area
8	T. Flannery	Occurrence and Distribution of Vertebrates in the Solomon Islands
9	A. Fearnside	Pilot Area Study
10	P.N. King	Project Identification Document
11	R.B. Tennent	Statistical Aspects of Inventory Design & Volume Function Preparation
12	J.M. Aldrick	The Susceptibility of Lands to Deterioration in the Solomon Islands
13	E.D. Shield	Plantation Opportunity Areas in Solomon Islands
14	E.D. Shield	Policies & Practices for the Management of Indigenous Forests in Solomon Islands
15	J.R. Schenk	The Structure and Environment of Forests in the Solomon Islands*
16	R.B. Tennent	Volume Tables for Indigenous Trees of the Solomon Islands
17	M.T. Olsen & M.H. Turnbull	Assessment of the Growth Rates of Logged and Unlogged Forest in Solomon Islands: Review of Literature
18	M.T. Olsen & M.H. Turnbull	Assessment of the Growth Rates of Logged and Unlogged Forest in Solomon Islands: Final Report
19	P. Schoeffel G. P. Fitzgerald & A. Loveridge	Forest Utilisation in the Solomon Islands: Social Aspects and Issues
20	W.D. Incoll	Principles & Guidelines for Forest Resource Planning in Solomon Islands

SOLOMON ISLANDS NATIONAL FOREST RESOURCES INVENTORY: MANUALS

No	AUTHOR	TITLE
1	E.T. Hammermaster	Inventory Procedures
1	(supplement)	Introduction to Statistics for Forest Inventory in Solomon Islands
2	A. Scott	The Customary Plants Data Base
3	R.J. Wilson	Introductory API for Solomon Islands Forestry*
	M.T. Olsen & M.H. Turnbull	Assessment of the Growth Rates of Logged and Unlogged Forest in Solomon Islands: Manual of Methods
	M.T. Olsen & M.H. Turnbull	Assessment of the Growth Rates of Logged and Unlogged Forest in Solomon Islands: Manual of Methods (Literature Rev)
4	R Fenwick	NATRIM: Operator Documentation

CONFERENCE PROCEEDINGS

National Coordinated Information Workshop: Proceeding of a National Workshop to Generate Responses to Modern Information Systems in the Solomon Islands, Honiara 19 - 23 April 1993

REGIONAL REPORTS

No	REGION
1	National Overview and Methods
2	Guadalcanal, Florida and Russell Islands
3	Malaita
4	Choiseul
5	Isabel
6	Western Province
7	Makira Ulawa Province
8	Temotu Province
9	Rennell and Bellona Province
	Inventory of the Allardyce Tract

APPENDIX TWO

LAND COVER AND FOREST TYPE CLASSIFICATION

APPENDIX TWO

LAND COVER AND FOREST TYPE CLASSIFICATION

DESIGN OF THE FOREST TYPE CLASSIFICATION

Classification requirements

The nature and extent of the forest types that are relevant to the inventory must be identified and mapped at an indicative level. Air photo interpretation (API) must be consistent, represent what can be observed on the ground, and relate to what is measured by the field teams.

The classification of forests must also be feasible and meaningful, and structured to provide for additional types as they become evident during the inventory or in subsequent, more detailed inventories. The classification should represent a wide range of values for both wood and non-wood resources.

Forest typing and classification

The resolution and classification of forest typing are generally determined by the complexity and extent of the area, access for ground reconnaissance and the quality of the aerial photography.

Each regional report shows the aerial photography that was used in planning the field work and for forest typing. The colour photography flown in 1992-93 at a scale of 1:25,000 was arranged by the inventory and was found to be of high quality. Earlier black and white photography flown in 1984 was also adequate for the purpose. However, the 1979 and earlier photography could only be accepted on the assumption that there has not been significant disturbance of the canopy during the intervening years.

For the inventory, *"forest type"* is defined as *any group of tree dominated stands which possess a general similarity in composition* and character". A forest type may encompass either a broad area of forested land of mixed but distinctive species composition and character (e.g. freshwater swamp forest of mixed composition) or a more discrete area of forest dominated by a single species such as freshwater swamp forest, dominated by *Terminalia brassii.*

Species type maps for all of the Solomon Islands have not been prepared by the inventory, as it is considered more appropriate that maps be made as required and with specific attributes from the FRIS and NATRIM databases.

OVERVIEW OF FOREST AND LAND COVER TYPES

Following the above approach, the forest and land cover types were derived by the inventory.

FOREST CONDITION

From air photographs an indication of forest condition may be ascertained from the extent of canopy disturbance, resulting from impact by natural events such as cyclones or anthropogenic activities such as clearing, cultivation and logging. An attempt is made to provide an index of forest condition by three canopy density classes.

STRUCTURE OF THE FOREST TYPE CLASSIFICATION

The classification of forest types is based on a hierarchical structure involving three levels of stratification. Each of these levels is laterally open-ended so that new types can be added at any time. The three levels are:

1	ECOLOGICAL CLASS
2	CANOPY DENSITY CLASS
3	CROWN SIZE CLASS

LEVEL ONE STRATIFICATION - ECOLOGICAL FOREST CLASSES

Level one stratification involves a dissection of vegetation and land cover into ecological classes. These are distinctive areas displaying characteristic patterns on aerial photographs and essentially comprise a suite of species adapted to prevailing site conditions.

The following are ecological classes derived by the inventory.

SALINE SWAMP FOREST

Class	Composition
SM	Saline swamp forest, mixed spp composition
SA	Mangrove
SN	Degraded forest

FRESHWATER SWAMP FOREST

Class	Composition
FM	Freshwater swamp forest, mixed spp composition
FS	Sago swamp forest
FT	Terminalia swamp forest
FN	Degraded forest
FL	Logged forest

LOWLAND FORESTS (ON NEAR LEVEL LANDS)

Class	Composition
LM	Lowland rainforest, mixed spp composition
LN	Degraded forest
LL	Logged forest

HILL FORESTS

Class	Composition
HM	Lowland rainforest on hills, mixed species composition
HN	Degraded lowland rainforest on hills
HL	Logged forest

MONTANE FOREST

Class	Composition
UM	Upland forest on hills, mixed spp composition

NON FOREST AND OTHER AREAS

Class	Composition
NH	Herbaceous swamps, mixed spp composition
NR	Braided river courses
NC	Cloud obscured areas

LEVEL TWO STRATIFICATION - CANOPY DENSITY CLASSES

Considering the frequency of cyclonic events and their impact on the forest as well as anthropogenic disturbance (gardens, logging etc), a second and third level of stratification were derived to provide an indication of forest condition.

The second level of stratification is a dissection of the primary canopy for each of the above ecological classes into density classes as follow.

CANOPY DENSITY CLASSES

Class	Density	Description
1	0-20%	Degraded forest areas Cleared to sparse remnant forest Primary canopy: very open to isolated trees
2	10-50%	Severe-moderately disturbed forest areas Sparse to mid-dense forest Primary canopy: clearly separated Moderate-relatively undisturbed forest areas
3	40-100%	Mid dense to dense forest Primary canopy: separated to overlapping

LEVEL THREE STRATIFICATION - CROWN SIZE CLASSES

Level three stratification is a dissection or classification of each of the above three canopy density classes into crown size classes. As for all the above stratification levels reference is made to the primary canopy only.

CROWN SIZE CLASSES

Class	Crown size
S	small-medium
M	medium-large
V	various

MAP CODING OF LANDCOVER TYPES

Final typing from API resulted in forest types which are composites of stratification levels two, three and four, as shown in the following example:

L1	ECOLOGICAL CLASS	eg:lowland rainforest on hills	HM
	+		
L2	CANOPY COND'N CLASS	eg: mid-dense to dense forest	3
	+		
L3	CROWN SIZE CLASS	e.g.: small to medium crowns	S

The inventory's coding for photo annotation and mapping involves four characters:

first two characters designating ecological class

third character designating. canopy density class

fourth character designating.crown size class

Photo coding for the above example is shown thus: HM3S

This indicates a fine-crowned, mid-dense to dense lowland rainforest occurring on hills.

APPENDIX THREE

EFFECTS OF CYCLONES ON THE SOLOMONS FOREST

APPENDIX THREE

EFFECTS OF CYCLONES ON THE SOLOMONS FORESTS

It is commonly believed that destructive cyclones do not occur below 8° South (J. McAlpine, pers comm) this is not precisely confirmed by SI experience, since cyclones have damaged Choiseul (approx 6° 40' to 7° 20' South) and tropical depressions which develop into cyclones do occur further north than 8° south. However, the lack of cyclone damage recorded during the Choiseul inventory confirms that Choiseul (and, presumably, the Shortland Islands) have forests that are little damaged by cyclones, and that the amount of damage to forests increases as one moves south. The New Georgia islands of Western Province generally do not seem to be in the regular path of cyclones, an exception being Kolombangara where cyclone Annie damaged the forests and passed over Gizo.

This may account for a general lowering in volumes per hectare from north to south, with Western Province, Choiseul and the Shortlands forests having higher stockings than those in Makira, Malaita, Isabel and Guadalcanal, which in turn have higher volumes than the forests of Rennell and Temotu.

This is illustrated by the island of Utupua (Temotu Province) where the records of cyclones suggest a forest with a very low stocking of trees over 60 cm diameter and in fact the forests were found to carry such a low volume (only one large tree was found in 78 plots) that it was classified as "not commercial" even though there has never been any commercial logging there. Cyclones affected Utupua in 1937, 1938, 1948, 1985 and 1987 (Radford and Blong).

The general pattern is that cyclones develop in SI waters and then move southwards, intensifying and developing stronger wind speeds as they go, so that the more destructive events are associated with cyclones to the south, usually beyond Solomon Islands territorial limits.

Therefore cyclones in SI often do not have the very strong winds that are associated with cyclones elsewhere, winds being generally in the range of 80 to 110 km per hour.

Thus, Namu which was the most damaging cyclone to occur in the Solomon Islands, in May 1986 was a moderate intensity system with a central pressure of 1002.6 hecta pascals. Namu had a wind speed over Malaita of 92-110 km ph and caused moderate wind damage at Kirakira with 111 km ph winds being recorded. It was a slow-moving cyclone and most of the damage was caused by the very heavy rains that caused extensive flooding and land slips (Radford and Blong, 1992).

By contrast Cyclone Winifred which crossed the coast of north Queensland on 1 February 1986 had a central pressure of 957 hecta pascals, winds which gusted to 176 km per hour, and caused extensive damage to 150,000 ha of forests before losing its intensity (Unwin *et al*, 1988). Cyclone Nigel which damaged forest plantations in Vanuatu in 1985 was reported to have had winds up to 180 km per hour (Neil and Barrance, 1987).

Most cyclones occur between November and May, with Ida which damaged Isabel on 30 May and 1 June 1972) being the latest since records began to be kept in the 1950s.

Recent cyclones which are known to have damaged forests include:

- **ANNIE - 1967,** which damaged forests on Kolombangara, including the plots forming part of the Kolombangara Ecological Study;

- **IDA - 1972,** which originated off Choiseul and then travelled along the NW-SE axis of Isabel and therefore damaged forests extensively, including the Allardyce forests and associated logging operation;

- **EMILY - 1972** (Makira);
- **KERRY - 1979** (Ulawa and Makira);
- **NAMU - 1986** (Malaita, Guadalcanal and Makira);
- **NINA - 1993,** which passed over Rennell with more force than usual in Solomon Islands and then affected Nendo and Utupua Islands in Temotu Province.

Patterns of Damage to Forests by Cyclones

Damage to trees includes:

- defoliation (e.g., *Casuarina equisetifolia* and *Calophyllum inophyllum*);
- desiccation of foliage;
- loss of minor branches and twigs;
- breakage of stems;
- uprooting (multi-directional) by wind;
- uprooting by land slips;
- trees washed away by floods.

- Canopies including epiphytes can be severely reduced, and twisting can lead to poorer timber quality (cited by Japanese log purchasers as a reason for lower prices for Solomon Islands logs). Breakage of stems and branches can make entry points for disease leading to rot and other defects.

Disturbance to a forest can be related to the characteristics of the particular cyclone:

- position of the forest in relation to the cyclone's area of maximum intensity and to the "left hand front" of the cyclone which also generates strong winds;
- intensity of the cyclone;
- rate at which the cyclone is moving; and
- the size of the "eye".

Thus cyclone Becky was said to have cut a 20 mile wide (32 kilometre) swathe through Malaita in 1968, and in 1985 cyclone Nigel brought winds in excess of 100 knots (180 km per hour) which caused severe damage to forests in Vanuatu in a 30 km belt either side of its centre.

The disturbance can be expected to be:

- greater on exposed ridge tops;
- and just over the crest of lee slopes (where turbulence occurs);
- caused by land slips and slides on steep slopes after soils have become saturated after very heavy rain (e.g., Namu).

Disasters of some magnitude could be expected if there were seismic disturbances when the soil was in this saturated condition with extensive land slips resulting in rivers being dammed; this could be followed in turn by severe flooding when the dams eventually break - as happened in Papua New Guinea in 1993, although this was associated with heavy rains that were not caused by cyclonic events.

Floods (exacerbated by build up of debris after logging) can cause extensive damage to garden sites, and villagers may have to re-locate their houses. This is particularly the case in flood prone parts of Guadalcanal, Makira and Malaita and led to the very high cost of damage caused by cyclone Namu in 1986.

On the coast, storm surges (tidal waves) may also cause damage and waves up to 14 feet (4.26 metres) have been recorded.

Disturbance to particular trees will depend on their position in the canopy, rooting characteristics, soil depth, canopy structure and leaf characteristics (heavy crowns and ease of loss of leaves).

Recovery by trees after cyclone damage depends on the coppicing and sprouting ability of the particular trees and can be rapid and widespread. Smaller trees and seedlings can also quickly take advantage of new conditions to grow into gaps caused by the cyclone.

Risk Avoidance

From the above it can be seen that risks of damage by cyclones should be less in the northern parts of SI, and in Western Province and that elsewhere, exposed slopes and ridges should be avoided as plantation sites. It should also be noted that it is wise to avoid planting species which do not come from areas with a history of strong winds (eg *Eucalyptus deglupta* which is from PNG and northern provenances of *Acacia mangium*). Risks could be spread if plantations, etc were established at more than one place, separated by hills, etc.

REFERENCES:

Neil, P.E., and Barrance, A.J., Cyclone damage in Vanuatu, Commonwealth Forestry Review 66 (3) 1987.

Radford, D.A., and Blong R.J., Natural Disasters in the Solomon Islands, 2nd edition, School of Earth Sciences, Macquarie University, Sydney, 1992

Unwin, G.L., Applegate, G.B., Stocker, G.C., and Nicholson D.I., Initial effects of Tropical Cyclone "Winifred" on forests in north Queensland, Proceedings of the Ecological Society of Australia 15:283-296, 1988.

APPENDIX FOUR

DETERMINATION OF MERCHANTABLE VOLUMES AND AREAS,

AND REDUCTIONS IN AREAS FOR ENVIRONMENTAL REASONS

DETERMINATION OF MERCHANTABLE VOLUMES AND AREAS, AND REDUCTIONS IN AREAS FOR ENVIRONMENTAL REASONS

This appendix describes the approaches taken in determining merchantable (loggable or accessible) areas from total or gross areas, merchantable volumes from gross volumes, and on reductions of areas for environmental and social factors.

This approach gives areas that can be logged using the methods in use during the course of the inventory, which rely on bulldozers with good roads for extraction to log ponds. Other methods may be used in the future, such as cable logging, helicopter logging and balloon logging, in these cases, the area that can be logged should be re-calculated.

The inventory used the geographical information system ERM-S which is part of the FRIS to estimate various areas that should not be logged. This was done by using overlay analysis (maps put one on top of the other in the computer) to calculate reduced areas, using different critera to exclude land that was on erodible soils, alongside watercourses, swamps and mangroves, within one kilometre of villages, etc. It is pointed out that this was done to give an indication of areas only and that it is strongly recommended that others develop their own criteria and do their own calculations.

1. DETERMINATION OF MERCHANTABLE (LOGGABLE) FOREST AREAS

Definition

> *Merchantable forest* is assumed to be "a forest that contains a minimum of 25 cubic metres of timber that is greater than 60 centimetres in diameter at breast height (or above buttress); this is a gross figure for all saleable species of form class 1 and 2[1]".

This forest should yield 15 cubic metres of timber per hectare after allowing for hidden defects in timber and for a "utilisation factor"[2].

This of course is a general definition and will be more applicable in some cases than others, depending on location, species and markets. The definition includes export quality logs and sawlogs and applies to viable commercial scale operations (such as export logging) but not to operations based on portable sawmills.

The forest types which were identified for the inventory classified the forests into several merchantable and non-merchantable classes. These classes are based on topography, canopy size, percentage of crown cover and height of canopy (see Appendix Two for details). They are more detailed than is strictly necessary from the commercial forestry point of view.

---

1. The inventory classified all trees measured in three form classes: form class 1 is a tree with export quality logs, form class 2 is a tree with millable saw logs, and form class three is a tree which does not contain logs that are currently utilisable.

2. When a forest is logged, the actual yield is usually overestimated by a certain percentage. This percentage is called the "utilisation factor".

To ascertain the area of merchantable forest, it is necessary to apply the criteria relating to slope, altitude, already logged areas, forest types and some areas that are excluded on the grounds of what would be a viable operation (usually the small area involved). This leads to a forest which can be defined as follows:

> *Merchantable area* (or loggable area) is the area that could be logged if no environmental or social constraints were placed on the operation: it is the basic position from which any later exclusions can be made for environmental or social reasons.

Slope

Three slope categories were obtained from contour lines on the 1:50,000 topographical maps. At this scale, contours are quite broad and cannot depict many areas with short steep slopes which are greater than 30 degrees. To allow for these areas, and for the unreliable nature of the data, 50% is deducted from the area of land that is classified as 15 to 30 degrees slope. (In practice this may underestimate the amount of accessible timber.) The slope categories are as follows.

SLOPE	ACCESSIBILITY
0 to 15 degrees	all merchantable
10 to 30 degrees	50% merchantable
over 30 degrees	none merchantable

Altitude

The current Standard Logging Agreement restricts logging to areas below 400 metres. There seems to be no good ecological or environmental reason for this, other than that the land usually becomes steep (over 30^{o}) before this altitude is reached. The altitudinal limit for hills forests has been raised to 600 metres, except on Guadalcanal where a limit of 750 metres has been applied.

Up to these limits, the forests still contain trees of good form, above them, however, the trees are somewhat stunted with short boles. However, forests classified as "mountain" or "upland" forests have not been included in the area of merchantable forest.

Logged forests

Forests classified as "logged forest type" are not included in the merchantable area if the logging has been done recently. This is because there are grave doubts that the forest will recover within the foreseeable future from the too-severe logging.

There has been substantial logging since some of the aerial photographs which were used for API have been taken. It was necessary to up-date these areas from the 1:80,000 photographs taken in 1992 and 1993 to revise the 1:50,000 topographic maps.

Forests that had been logged more than 20 years ago could not be identified on the various series of air photographs. In some cases (Mbanga Island, Allardyce, Temotu and northern Guadalcanal) the forests have recovered from what appears to have been less severe logging operations.

Forest Types

Areas occupied by the following types are considered to be fully merchantable ("commercial"):

Hills rainforest HM3V HM3M HK3V HK3M HX3M HX3V

Lowland rainforest LM3V LM3M LK3V LK3M

Freshwater swamp FT3M.

Areas occupied by the following are considered to be partly merchantable ("semi-commercial"). They are assumed to have a yield of 40% of the above types:

Hills rainforest HM2V

Freshwater swamp FT3V

HM2V contains mixed species hill forest with a canopy closure of 10 to 50 % (HM3V has a canopy closure of 40 to 100%). Poorer quality HM2V will not contain 25 cu m per ha of merchantable timber. (At Mbanga Island, the inventory found that HM2V carried 31.25 cu m per ha; at Allardyce HM2VA carried 44.8 cu m and HM2VL carried 29.3 cu m per ha.)

In FT3V, 40% of the area is considered merchantable. This type indicates scattered *Terminalia brassii* in deep swamps or alongside rivers or drainage lines.

Although much of the areas classified as FT3M carries trees with "punky heart", this is taken into account as a defect allowance (see below) rather than a reduction in area.

In Rennell, LM2V areas are also considered to be 40% merchantable.

HX, which occurs only in the Santa Cruz group is treated as HM.

Note that some smaller areas are classified as not commercial, e.g., in Table 4.2 of the regional reports on account of their small size.

Areas excluded

Some areas that carry or may carry forests of commercial quality have been excluded from the loggable areas, as follows.

Areas isolated by steep terrain (over 30 degrees slope).

Small dispersed forest areas, these are more suited to small scale, portable sawmilling.

Areas surrounded by non-commercial forests or swamps, e.g., forests surrounded by *Casuarina papuensis* or forests badly damaged by cyclones at Utupua.

Areas classified as 15 to 30 degree slopes, where these are concentrated or known to carry a high proportion of ruling or short slopes over 30 degrees.

2. DETERMINATION OF MERCHANTABLE FOREST VOLUMES

For the determination of merchantable volumes, only the plots which fall in merchantable types should be included.

Utilisation factor

When a forest is logged, the volume harvested is generally less than estimated. The differences not explained by internal defect and species acceptability are allocated to a "utilisation factor" which is applied to unseen external defects, trees missed when logging, loss on felling (shatter, breakage, etc).

A small study carried out during the pilot phase indicated that a 7.5% reduction should be applied to gross volumes to obtain net volumes for logs that will be sawn. If only export quality logs are to be harvested, then a higher figure would be warranted, and only form class one logs should then be considered.

Internal defect

No defect studies were carried out by the inventory, so factors to account for internal defects are suggested which are based on general experience:

Terminalia brassii	>100 cm diameter	40%
Terminalia brassii	<100 cm diameter	15%
Pometia pinnata	15% (varies according to site)	
Vitex cofassus	20% (due to log shape)	
All other species	10%	

T. brassii suffers from "punky" heart, especially in over mature trees and particularly in swampy situations.

P. pinnata suffers from "brittle heart" or incipient decay in some places, e.g., coraline limestone, and all or most of the bottom log can be lost in such cases.

Merchantable species

A list of species that are considered merchantable for saw milling and export logs has been collected by the inventory. This is presented below, together with a list of the more common commercial species in the Solomon Islands and their names in some of the SI languages. In determining gross volumes, all trees were measured, regardless of species. One reason for this is that species that presently are not considered merchantable may become merchantable as new markets and uses are discovered. The species that are not considered merchantable, i.e., they are not on the list of merchantable species (e.g., *Ficus* spp, *Dillenia crenata*, *Casuarina papuana*, etc) are excluded when merchantable volumes are determined.

3. REDUCTION OF AREAS FOR SOCIAL AND ENVIRONMENTAL REASONS

As mentioned above, the technique of overlay analysis was used to remove areas that inventory personnel considered should not be logged, to give a "reduced area". These area types are as follows (note that each regional report gives a list of the areas with their size in hectares).

- areas with very erodible soils (as identified by Hansell and Wall) or over 30 degrees slope;
- water course protection zones or "filter strips" (50m either side of water courses). This is as in the Standard Logging Agreement, but it is pointed out that the requirement to leave protection strips only along streams that are marked on the 1:50,000 topographic maps must inevitably result in severe damage to water supplies to villages);
- swamps;
- mangroves;
- areas recommended for protection to conserve important environments (listed in Chapter Four, and in each regional report);
- a zone of 1 kilometre around each village;
- areas above 600 metres altitude (except in Guadalcanal);
- domestic water supply catchments (too often the inventory was unable to get clear indications of these areas).

The same technique was used to identify areas where logging should be permitted, but with modifications.

- swamp protection zones (within 200 metres of freshwater swamps);
- mangrove protection zones (within 200 metres of mangroves);
- catchments of important reefs;
- areas with highly erodible or moderately erodible soils;
- a zone around each village of 2 km.

It is important to note that the tables in the regional reports contain overlapping areas, e.g., watercourse protection zones may also be on erodible soil types and so the figures will not add up to a meaningful total, or may even exceed the total area of a particular island. Also some of the areas where logging is to be restricted will be included in areas where it is recommended that logging is not to be permitted.

In each regional report, a table is given of the restrictions that should be placed on logging or other wide-scale development such as clearing for plantations. An example of this table is given below. Given the scale of the inventory (a national scale) it is not possible to prescribe detailed restrictions that should be placed on all areas.

RESTRICTIONS ON DEVELOPMENT INVOLVING MECHANICAL DISTURBANCE TO FORESTS

TYPE	CHARACTERISTICS	CONSTRAINTS TO DEVELOPMENT	AREAS
1	robust environments conserved elsewhere; highly modified environments; stable soils with low erosivity and low seismicity	standard logging prescriptions to be observed	hills & lowland forests that are not otherwise excluded S_0 lands
2	important downstream resources to be protected stable soils but erosive climate or seismic OR unstable soils with low erosive climate and no seismic activity	additional restrictions to be applied	catchments draining to lagoons & reefs mangrove and swamp protection areas S_1 lands
3	fragile ecosystems and ecologically significant environments that are conserved elsewhere susceptible soils with erosive climate or actively seismic	access routes only or EIA to be prepared by proponents	significant swamps and other important habitats (e.g., of rare species) water supply catchments S_2 and S_3 lands 2 km village resource zones
4	strict conservation areas susceptible soils with erosive climates AND actively seismic culturally significant sites	development and logging not permitted	nominated areas known habitats of endangered species S_4 lands 1 km village resource zones; tambu sites

* EIA = environmental impact assessment